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This book is based on the notes of lectures given by the author at the Universities of St. Andrew's, Bern, and West Berlin, and is intended to serve as an introduction to the subject for advanced students. The author has confined himself to matters which are reasonably well settled and has endeavoured to bring out the essential parts of the subject. Little previous knowledge is required by the reader beyond the elements of the differential and integral calculus, and of analytical geometry. Many examples are included to stimulate the reader into thinking critically. The text was written in German and was translated by Dr. Kahn of Manchester University.

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Scientists and Legislation

Legislation that involves scientific or medical questions poses a special problem for Congress, a problem that is primarily one of communication. How can the special knowledge of the scientists be communicated to Congressmen, who, in general, have a background in law or business? To legislate wisely the Congressman must grasp the essentials of the scientific knowledge about the issue in question. What is the best way to get this information?

The time-honored way to do this—and it is not without merit—is for a Congressman to specialize in a particular committee or subcommittee that is concerned with matters pertaining to science and to attend hearings where scientists, testifying as expert witnesses, discuss the scientific implications of proposed legislation. By a long experience of this kind a Congressman may learn how to translate scientific language into his own terms and thus develop a good grasp of the relevant scientific facts and opinions.

But even for those committee members who have had this experience—and many inevitably have not—it is a difficult if not an impossible task to judge the significance of the discrepancies in scientific testimony from a variety of scientists, each with a different speciality. One need only recall the array of scientists and physicians who from time to time have testified before the Joint Committee on Atomic Energy: radiologists, geneticists, pathologists, biochemists, meteorologists, physicists, chemists, and so on. Each, quite understandably, approached the scientific questions from the viewpoint of his speciality. The result of this was that differences tended to be exaggerated and points of fundamental agreement tended to be obscured.

Difficulties of this sort led the House Committee on Interstate and Foreign Commerce to try a different way of gathering scientific opinion in its survey of major diseases in 1953. Instead of relying on individual testimony, the committee, with the advice of the National Academy of Sciences, assembled panels of expert witnesses who, in the words of the committee, ". . . were given a free hand to discuss specific aspects of the diseases in which they were interested, as well as to exchange views on other matters relevant to their areas of work. . . . The outcome was an extraordinarily informative and pertinent testimony. . . ."

The panel method was found, as the quotation from the committee indicates, to be so superior to individual testimony that the committee used it again in 1955 when the safety and efficacy of the Salk vaccine was in question and also in the hearings recently held on food additives (see editorial in *Science* for 27 Sept. 1957). The great advantage of the method is that the members of the panel question each other before they are questioned by committee members. Consequently, the committee member knows what the differences and agreements among the scientists are before he asks his own questions.

The panel discussion is, of course, an old story to scientists. It is gratifying to see how well it can be adapted to a new use, the marshaling of scientific opinion in the aid of sound legislation.—G. DuS.

Kodak reports on:

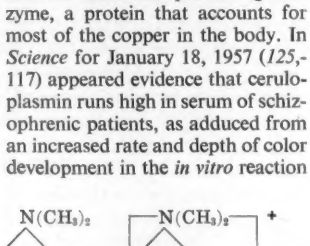
oxidation and the ills of the spirit . . . photographic materials for looking up

Crazy!

During the past spring we noted a sharp upturn in the volume of our correspondence with psychiatrists. They all wanted to know whether we could supply the compound N,N-dimethyl-p-phenylenediamine dihydrochloride. In accordance with practice in the retailing game when you don't have exactly what the customer asks for, we replied to each that we would be happy to supply the monohydrochloride at $2.20 for 25 grams. This rejoinder got us nowhere.

Thus rebuffed (and deservedly so), we dipped a little into the fast-breaking literature of the borderland between chemistry and the ills of the spirit.

We learned about ceruloplasmin. It's an oxidation-promoting enzyme, a protein that accounts for most of the copper in the body. In *Science* for January 18, 1957 (*125*,-117) appeared evidence that ceruloplasmin runs high in serum of schizophrenic patients, as adduced from an increased rate and depth of color development in the *in vitro* reaction



Here we found a region with landmarks familiar indeed to anyone who has thought deeply about photographic developers. p-Phenylenediamine is parent to a numerous family of aromatic amines that assume color when oxidized. Stability is enhanced by various substitutions and in the dry crystalline state by conversion to some salt or other.

If, in this case, the author chose to have two methyl groups on one of the amine nitrogens and, instead of one, two molecules of HCl to preserve his reagent on the shelf until ready for use, that was his privilege. So also is it the inalienable right of any neurophysiologist who wishes to pursue this line of laboratory investigation to be able to buy this dihydrochloride ready made without bothering to add the appropriate quantity of HCl to a solution of the base or the monohydrochloride. (The right may be exercised by purchase from us of *N,N-Dimethyl-p-phenylenediamine Dihydrochloride* (Eastman 7423) at $3.05 for 25 grams.)

And now, alongside one group of wise men who explain the tension of the times in terms of socio-economic forces and another group of wise men who watch the war between the id, the ego, and the super-ego, there stands huddled in stimulating talk a new group of wise men who point out that the tranquillizing chlorpromazine and Rauwolfia alkaloids are potent oxidase inhibitors. But even they seem largely to agree that anybody who at this time would depend solely on these enzymatic measurements for a positive diagnosis of schizophrenia is crazy.

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A hobby for clear nights

The following proposal offers little prospect for fame, advancement, or even succor to suffering humanity. All it offers is a chance to add a few grains to the mortar in the edifice of science. Here and there are a few happy people who enjoy that sort of thing.

Why not celebrate the International Geophysical Year by gathering some data for the IGY Auroral Data Center, Rockefeller Hall, Cornell University, Ithaca, N. Y. (or, if you are Canadian, for the IGY Auroral Centre, National Research Council, Ottawa)? Write them for instructions.

The sun is now at the stormy stage of its cycle. It sends forth bursts of electrons and ions which set the night sky ablaze with the rayed arcs, homogeneous arcs, pulsating arcs, pulsating spots, glows, rays, coronas, and flames of the aurora. On clear, moonless nights when the show is on, in places without overwhelming competition from smog-scattered illumination emitted by certain atmospheric gases when they are excited in glass tubes for the greater glory of hot dogs and horsepower, it is worth looking up in the sky for.

Looking is all you need do. Either the Center or the Centre supplies free report forms carrying a printed protractor for measuring angles in the sky.

Photographic records, however, are also wanted. To make them one needs a camera lens faster than *f*/4.5. (The *Cine-Kodak K-100 Cameras* of the U. S. and Canadian official observing programs have *f*/1.4 lenses.) With *Kodak Royal Pan Film* or *Kodak Tri-X Film* at *f*/3.5, reasonable exposure times for medium to bright auroras run from 18 to 60 seconds. Much faster and better for the purpose is the phenomenal new *Kodak Royal-X Pan Film*, but it must be processed according to the package directions rather than through usual commercial channels.

All auroral photographs should be labeled with the observer's location, the double date (e.g. October 17-18), the exact time and time zone, the azimuth and elevation of the center of the photograph as close as you can (ideally by identifying any bright stars in your picture), and the usual photographic data. Aim along the meridian and start on the first minute of each five, first the southernmost part of the display because that is the most interesting scientifically, then the northernmost part, then anything else on the meridian, then prominent forms in the east, and finally toward the end of the five-minute interval, prominent forms in the west. That way there is hope for simultaneous coverage from widely spaced points. South of 40° N. in the eastern U. S. and south of 45° in the west, any aurora is worth photographing immediately, schedule or no schedule. A red one is worth photographing at once, anywhere.

At Cornell, if necessary, they'll put the graduate students' wives to work reading the flood of photos and reports that ought to come in.

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Weather Modification and Smog

M. Neiburger

The three essential ingredients in the recipe for the Los Angeles type of smog (*1*) are (i) sources emitting pollution into the air, (ii) atmospheric conditions which deter or prevent rapid transport of these pollutants in the atmosphere, and (iii) solar radiation for the photochemical reactions which transform the relatively innocuous pollutants into substances which cause irritation to the eyes and the respiratory tract and damage to plants. In the Los Angeles area the first ingredient is continually present and constantly increasing. The second ingredient, the lack of dispersal by atmospheric motions, and the third, the intense short-wave radiation, depend on weather conditions, and the conditions in the Los Angeles Basin are predominantly favorable for accumulation, rather than dispersal, of pollutants and for plentiful sunshine for photochemical reactions during much of the year (Fig. 1). The prevalence of the subtropical inversion and the preponderance of light winds or calms make it possible for objectionable concentrations to accumulate in the basin within the course of a single day, and days with low inversion tend to be cloudless and bright.

It is frequently suggested that it might be simpler to attack the problem of eliminating the second ingredient or the third rather than the first, since the first ingredient is so intimately associated with a healthy industrial and economic development.

In the present article, the various proposals for modifying the weather in order to eliminate smog are discussed. The conclusion, unfortunately, is that elimination of smog by weather modification is even more difficult or costly than control at the sources. This applies, of course, only to those proposals which have thus far come to my attention. It is quite conceivable, however unlikely, that someone will come forward with a feasible scheme. My intention in this article (*2*) is not to discourage speculation along these lines, but only to insure that persons who engage in such speculations are aware of the proposals which have been made previously, and the reasons why they are impractical. With this background to guide their thinking, it is hoped that further speculation will not be repetitive and that it will have a better chance of being fruitful.

The author, who was formerly senior meteorologist at the Air Pollution Foundation, Los Angeles, Calif., is now chairman of the department of meteorology at the University of California, Los Angeles. This article is based on a paper presented at the Technical Conference of the Institute of Geophysics in Nov. 1956.

Meteorological Factors Leading to High Pollution

The conditions which are responsible for the accumulation and lack of dispersion of pollutants emitted into the atmosphere in the Los Angeles area are part of a large-scale pattern associated with dynamic processes involving tremendous quantities of mass and energy. The subtropical inversion which prevails over Los Angeles is characteristic of the entire eastern portion of the Pacific Ocean as well as of the subtropical oceans and the adjoining west coasts of continents throughout the world. The inversion is produced by subsidence of air circulating from the north around a high-pressure center which is present over the eastern North Pacific Ocean most of the time during the warm months and frequently at other times during the year.

The prevalence of light winds and calms over the Los Angeles Basin is likewise associated with the basin's position in relation to the general circulation of the atmosphere. The normal wind in the Los Angeles area may be regarded as a monsoon, or seasonal wind, on which is superposed a diurnal sea-land and valley-mountain wind effect. In summer, the prevailing seasonal surface wind is southwest or west, representing the tendency of the air to flow from the high-pressure area over the ocean to the thermal low over the interior desert. The addition of the effects of diurnal heating and cooling result in moderate winds from the ocean during the day, and calm or light land breezes from the north and east at night.

To illustrate the nature and significance of the inversion, Fig. 2 shows the average variation of temperature with height at Long Beach at 7 A.M. in September. On the average, the inversion layer begins at 475 meters above sea level. Below this level the temperature decreases with height, as is normal in most places and situations in the lower atmosphere. Above 475 meters, however, the temperature increases as one proceeds upward, until the top of the inversion layer is reached, at 1055 meters, at which point the temperature begins to decrease with height once more. It has been found (*3*) that, as one proceeds inland from the coast to the foothills, the height of the inversion above the ground is, on the average, about constant.

To see why the base of the inversion acts as an effective lid on the upward dispersion of pollutants, it must be remembered that, when a parcel of air rises, it cools at a rate of about 1°C per 100 meters of rise. If a parcel of air is given an upward impetus from the ground, it will arrive at any level below the inversion with a temperature only slightly lower than that of the surrounding air and, thus, will be subjected to very little downward force. Consequently, it would have a moderately long period during which it could mix with its surroundings before it sinks. On the other hand, air which rises into the inversion immediately finds itself much cooler than the air surrounding it and is quickly accelerated downward, so that it gets little opportunity to mix its contaminants with the inversion air.

The typical wind regime in the Los

Angeles Basin during the warm season, which includes most days with severe smog, is illustrated in Figs. 3 and 4. Figure 3 shows streamlines and isotachs (lines of equal speed) at 2:30 P.M. P.S.T. on 21 September 1954, when the sea breeze was near its maximum. Most of the streamlines originated near the west coast of the basin, and the wind speed was greatest there. During the afternoon and early evening the sea breeze died down and was replaced by a land breeze. Figure 4, the map for 2:30 A.M. on 22 September, is fairly representative of the entire period from 8:30 P.M. to 8:30 A.M. At this time the streamlines were generally the reverse of those at 2:30 P.M. The speeds were 2 miles per hour or less over most of the basin. The speeds remained low until the sea breeze replaced the land breeze at about 9:30 the following morning. The daytime hours are thus characterized by light or moderate winds from the ocean, and during the night and early morning hours gentle land breezes or calm conditions prevail. From the standpoint of air movement, the concentrations of pollutants emitted during the night and morning hours build up to high values, and then, with the onset of the sea breeze, the air containing these high concentrations is transported across the basin.

Proposals for meteorological modification are ordinarily aimed at increasing the volume into which the contaminants may spread, either by raising or eliminating the inversion or by causing the air to move more rapidly across the basin. Occasionally methods have been proposed for reducing the solar radiation below the level required for photochemical reactions. In the following sections, each of these types of proposals is discussed in turn.

Penetrating or Dissipating the Inversion

The first idea which suggests itself to one who is aware that the inversion is a prime factor responsible for the high concentration of pollutants is to consider ways of eliminating it or at least "punching a hole" in it. In considering the practicality of this idea, it is important to realize exactly what is meant by the phrase *eliminating the inversion*. It is not at all a matter of removing the air in the inversion layer. If one were to do so, of course, the result would be to have the warmer air above the inversion top immediately in contact with the cool air at the inversion base, and thus have a still more impenetrable ceiling on the upward movement of pollutants.

Elimination of the inversion can mean only one of two things: (i) cooling all of the air from the inversion base upward to a temperature below that at the inversion base, or (ii) warming all of the air below the inversion top to a temperature higher than that at the inversion top. Since there is much less air below the inversion top than there is above the inversion base, it is obvious that the simpler procedure would be to raise the temperature of the air up to the inversion top sufficiently to eliminate the inversion. "Punching a hole" in the inversion can be interpreted intelligently only as eliminating the inversion in the same fashion over a restricted area.

It is relatively simple to compute the amount of energy required to heat the layer below the top of the inversion sufficiently to eliminate the inversion. Assuming that the energy would be injected at the ground, the process of heating

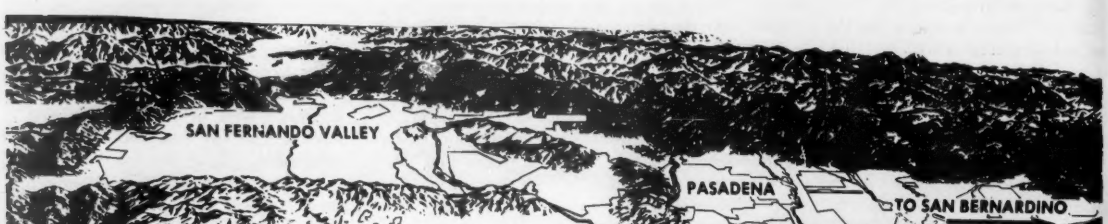

Fig 1. Topography of the Los Angeles Basin. [Watson Photos]

would necessarily establish an adiabatic lapse rate. If we assume that the lapse rate below the base of the inversion is initially adiabatic, and that the rate of temperature increase with height in the inversion is linear, it is easily shown that the energy E required to eliminate the inversion is given by the following equation:

$$E = c_p \rho [\gamma_d (H_T - H_B) + (T_T - T_B)] \frac{H_T + H_B}{2} \quad (1)$$

where c_p is the specific heat of air at constant pressure, ρ is the average density of the air below the inversion top, γ_d is the dry adiabatic rate of cooling, H_B and H_T are the heights, and T_B and T_T are the temperatures at the base and top of the inversion, respectively. For the average conditions at Long Beach at 7 A.M. in September, we have the following values: H_B, 475 meters; H_T, 1055 meters; T_B, 14.1°C; T_T, 22.4°C.

Inserting these values in Eq. 1, we find that the energy required to eliminate the inversion is 330 calories per square centimeter. The area of the Los Angeles Basin is usually taken to be 4000 square kilometers, so that the amount of energy required to eliminate the inversion over the entire basin is 1.32×10^{16} calories. It would take approximately 1.27 million tons of oil burned with 100-percent efficiency to produce this amount of heat. This would be equivalent to burning the amount of crude oil that is processed by all the refineries in the Los Angeles Basin during 12 days.

The preceding computation is made on the assumption that the air remains in place throughout the heating period. However, actually the process of heating itself would create horizontal motion which would bring new cool air in over the basin and thus tend to restore the inversion or to make it necessary to use more fuel in order to eliminate it. This, indeed, is what happens every day as a result of the sun's radiation. The total energy arriving at the earth's surface from the sun ranges between 500 and 700 calories per square centimeter, per day during the smog season. While part of this energy is utilized to heat the ground, to compensate for long-wave radiation, and in evaporation and transpiration, and part of it is reflected from the ground, a considerable proportion is utilized in raising the temperature of the air.

Ordinarily, the amount of heat going into the air is not sufficient to eliminate the inversion, except in the foothills, where the layer below the inversion top is shallower than it is over the coastal plain. However, the amount of heating which it achieves is sufficient to set up the sea breeze and bring in the cooler air over much of the basin. The incoming cooler air results in a greater intensity of the inversion than would exist if the direct effect of heating were not accompanied by its indirect consequence. The divergence of the air flow in the sea breeze actually results in a lowering of the height of the inversion base from morning to evening near the shore (*4*).

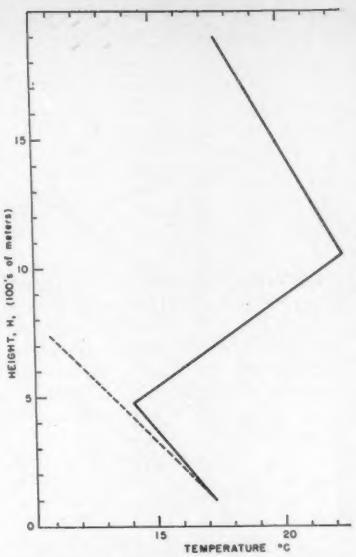

Fig. 2. Average variation of temperature with height at 7 A.M. P.S.T. in September at Long Beach, California.

The tremendous amount of energy required to eliminate the inversion completely leads to the suggestion that the heating be confined to a much smaller area. Since the amount of energy is proportional to the area, it is readily seen that, for instance, a 1-square-kilometer "hole" in the inversion would require 3.3×10^{12} calories, corresponding to burning about 320 tons of oil. It is often suggested that such a hole in the inversion would enable all the pollutants in the basin to pass upward. However, to cause any air to rise through the hole in the inversion, it would be necessary to heat it to the same potential temperature as that which was necessary for the elimination of the inversion. Thus, the amount of energy required would be the same, whether one attempted to get the air to pass through a small hole in the inversion or to eliminate the inversion over the area the air occupied originally.

There would be little advantage in building a stack up to the top of the inversion. Doing so might reduce the amount of radiation lost from the heated column and would surely eliminate the effect of entrainment, but the basic fact remains that all the air which one wishes to have penetrate the inversion must be heated to the potential temperature of the inversion top.

It has been suggested that if all the combustible rubbish in Los Angeles County were burned in a single large incinerator, adequate heat could be engendered to cause the pollutants from it to penetrate the inversion and, incidentally, to carry with them a large amount of entrained air containing other pollutants. It is estimated that about 14,000 tons of combustible refuse is burned in the basin. Allowing for its moisture content, we may reasonably assume a heat of combustion of about 5000 British thermal units per pound for the refuse. Using this value, we find that the total amount of refuse collected per day is adequate to eliminate the inversion over an area of about 10 square kilometers. Obviously, this is too small an area to create much interest from the standpoint of general removal of smoggy air. However, if it were possible to carry out the combustion in such a fashion that the pollutants therefrom penetrate the inversion, this would be one excellent way of eliminating a not inconsiderable source of pollutants, particularly particulates which reduce visibility. To achieve this, it would probably be necessary to erect huge stacks to heights of 2000 feet or more, in order to avoid entrainment and to conserve the high temperatures in the rising gases.

It has been suggested that some of the engineering difficulties in constructing stacks of this height can be avoided by having them take the form of pipes going up the slope of a mountain rather than having them be free-standing. The extra length of pipe in this case would increase the heat loss and decrease the flow rate, making it necessary to use tubes of larger diameter. The relative cost of constructing such a "smoqueduct" up the mountain, versus transporting the unburned rubbish up to incinerators at the top by truck or by conveyer belts, should be investigated if serious consideration is ever given to this scheme. Actually, it presently appears that the methods of disposing of rubbish by cut and fill or by well-designed incinerators equipped with adequate controls on the effluents represent more economical procedures.

In connection with the idea of eliminating the inversion by heating the air over the basin, it should be noted that the result would be to establish temperatures in the vicinity of 100°F over the basin for average inversion conditions, and somewhat higher values on days of low inversion which produce the most severe smog manifestations. Those who prefer these high temperatures to the smoggy conditions which are the unfortunate corollary to the otherwise more salubrious climate the inversion brings

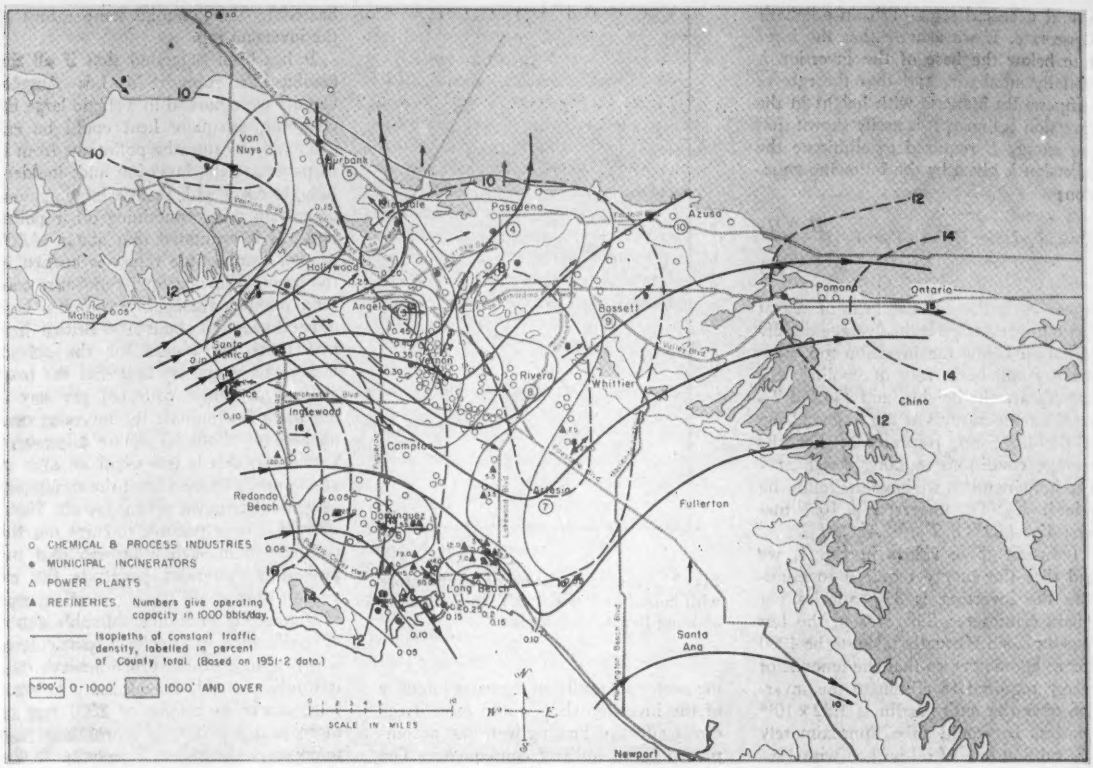

Fig. 3. Streamlines (solid lines) and isotachs (lines of equal speed, dashed lines) for 2:30 P.M. on 21 September 1954. Speeds are given in miles per hour beside station arrows and at ends of isotachs. The principal pollution sources and traffic density are shown in the background.

can achieve the same result with much less effort by moving to desert communities, such as Indio or Thermal.

Blowing the Smog Away

The other general proposal is to move the polluted air out of the basin. Leaving proposals to remove the mountains or dig tunnels through them for later discussion, it is of interest to compute the mass of air which would have to be moved and the energy required to produce the motion.

The average elevation of the inversion base is about 400 meters; over the 4000-square-kilometer area below this level in the basin, there are thus about 1.6×10^{12} cubic meters of air which, under average conditions of temperature and pressure on smoggy days, weighs about 2×10^9 tons. On a day with severe smog, the inversion is lower, but one might expect that, as a minimum, one-tenth of this amount of air, or 200 million tons, is involved.

L. A. Dubridge (*5*) has dramatized the problem by pointing out that this amount of air is twice the weight of all the steel produced in the United States in a year. This amount of steel, corresponding in size to a cube 1000 feet on a side, would be easier to move than the same amount of air "because at least you could load it on freight cars and haul it away."

Moving large masses of air is indeed more difficult than hauling away an equal mass of steel, for, in addition to the problem of getting hold of it, one must displace an equal volume of air (and thus an approximately equal mass) in the place one moves it to, and one must also provide for the energy to move in the air which replaces it. Rather than attempt to solve the complete problem of initiating the motion and providing for the necessary mass exchange, we shall confine our attention to computing the rate of energy expenditure required to keep the air moving over a flat area the size of Los Angeles—that is, the rate at which energy would be dissipated by ground friction. This amount is far below that needed to set up and maintain the motion in actuality, for it makes no allowance for the effect of the confining mountains, the opposing pressure forces which would arise the moment the air begins to move, or the turbulence created by the fans or other propelling apparatus.

If the wind stress is S dynes per square centimeter for a wind velocity v over an area A, the rate of work done in maintaining the wind is SAv. Now, the relationship of frictional stress to wind velocity may be expressed as

$$S = C\rho v^2$$

where ρ is the air density and C is a coefficient depending on the roughness of the surface over which the wind is blowing. Sutton (*6*) gives the following values of C for various surfaces, for v in centimeters per second: Ice, 0.002; close-cropped lawn, 0.005; thick grass up to 10 cm high, 0.016; thick grass up to 50 cm high, 0.032. Unfortunately no estimates are available for the value of C over the complex of surfaces comprising a city such as Los Angeles. It is reasonable to suppose that a value several times that for thick grass should apply.

The power required to keep the air speed constant is thus

$$E = C\rho A v^3$$

Taking A as 4000 square kilometers and ρ as 1.25×10^{-3}, we get $E = 5 \times 10^{10}\ C\ v^3$ ergs per second, or $5\ C\ v^3$ kilowatts. Table 1 gives the values of E for several

values of C and v. We see that if the entire Los Angeles area were as smooth as a golf green, it would require about 400,000 kilowatts to maintain a 4.5-mile-per-hour wind, and 3.2 million kilowatts to maintain a wind of 9 miles per hour against friction. For the actual character of the surface, it would seem to be reasonable to assume that the values given in the second column should be minimum, and that the actual values would probably be between those of the second and third columns. Thus the power requirements for maintaining 4.5- and 9-mile-per-hour winds over the Los Angeles Basin are probably more than 2 million and 16 million kilowatts, respectively.

For comparison, the capacity of Hoover Dam is 1.25 million kilowatts. The total capacity of all electric generating plants in California is about 6.5 million kilowatts, and in the United States about 100 million kilowatts. To maintain artificially a 9-mile-per-hour wind over the Los Angeles Basin would require at least 12 Hoover Dams, more than twice the electricity produced in California, or at least one-sixth of all the electricity produced in the United States.

Interpreted in terms of 5000-horsepower engines converting their energy to pure translation of the air with 100-per-

Table 1. Power (E) required to maintain wind speed (v) against friction, for various coefficients of friction (C).

Wind speed, v		Power E (kw) for various coefficients of friction C			
(m/sec)	(mi/hr)	0.01	0.05	0.10	0.50
1	2.2	5×10^4	2.5×10^5	5×10^5	2.5×10^6
2	4.5	4×10^5	2.0×10^6	4×10^6	2.0×10^7
3	6.7	1.4×10^6	6.8×10^6	1.4×10^7	6.8×10^7
4	8.9	3.2×10^6	1.6×10^7	3.2×10^7	1.6×10^8

cent efficiency, more than 4000 such engines would probably be required just to overcome surface friction to maintain a 9-mile-per-hour wind. In terms of fuel consumption, this power corresponds to 1000 tons of fuel oil per hour converted with perfect efficiency.

As stated previously, the problem of actually moving the air is far more complicated, and more requiring of energy, than simply overcoming friction. The fact that the latter process alone would require tremendous expenditures for equipment and fuel should be adequate to discourage proponents of the fan idea.

These computations likewise dispose of the proposal to build a tunnel through the mountains. If the tunnel were 100 feet in diameter, and if the air moved through it with a speed of 100 miles per hour, the amount passing through in a day would be 2.8×10^9 cubic meters, or about 0.2 percent of the air under the inversion when the inversion is at average height. If we consider that natural processes remove at least one-half of the air in the basin almost every day, we see that there is little likelihood that even 50 such tunnels would produce a noticeable effect on smog concentration, without taking into account the tremendous expense of digging such tunnels and the extreme difficulty of producing such velocities in tunnels several miles long.

In addition to proposals to blow away the smoggy air horizontally, there have been several proposals to achieve the same result by means of fans blowing air vertically. Usually ground-based fans blowing the smoggy air upward have been suggested, but there have also been two or three proposals to blow fresh air

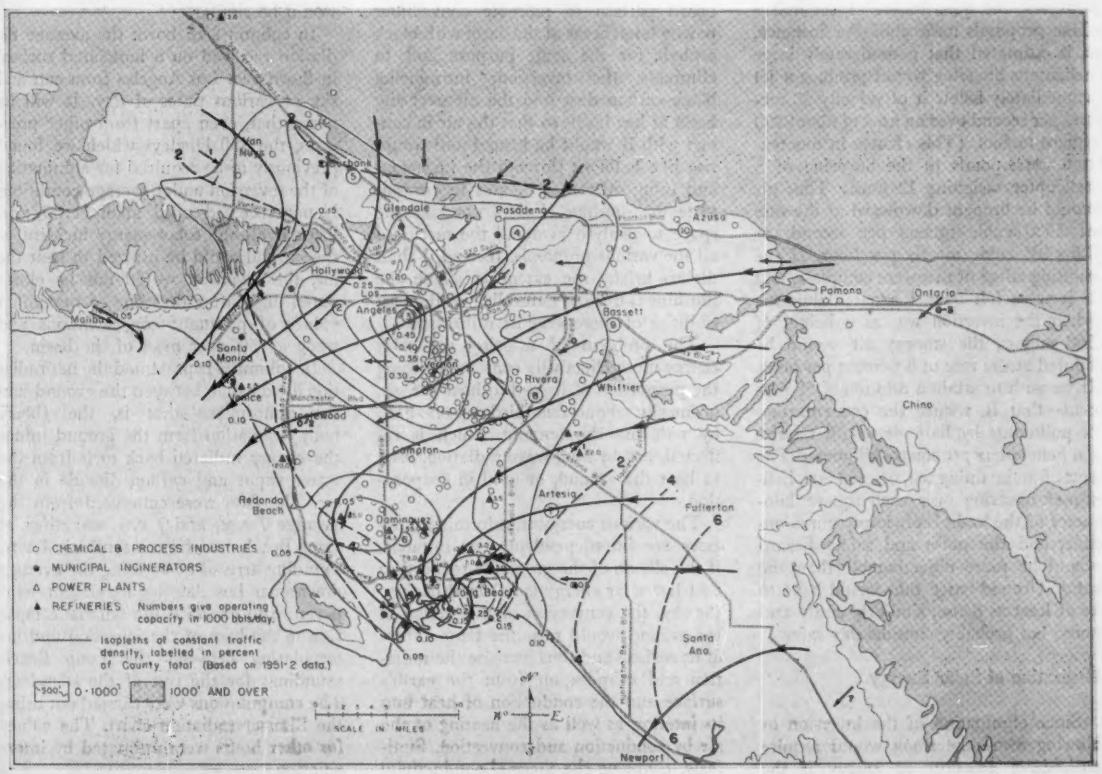

Fig. 4. Streamlines and isotachs for 2:30 A.M. on 22 September 1954 (see Fig. 3 for explanation).

downward from above the inversion base by means of hovering helicopters.

In addition to the problem of the quantity of air to be moved, the difficulty with ground-based fans blowing air upward is that, except for the effect of mixing, the air blown upward would be cooled adiabatically, rapidly becoming colder than its environment and thus subjected to a downward force which would decelerate it and ultimately accelerate it downward so that it would return to the ground. Mixing would, on the one hand, rapidly reduce the velocity of the rising air so that it would not penetrate as far into the inversion, and on the other hand, raise its potential temperature so that its equilibrium position would be somewhat higher and might under some circumstances be in the inversion layer.

The basic idea of having the horizontal fans take the form of hovering helicopters blowing down warmer air from the inversion layer to mix with the polluted air near the ground has the advantage that the mixture will be warmer than the environment at the ground and will rise to some position intermediate between the level of the helicopter and the ground. For the same amount of energy there would be a larger amount of dilution by air from the inversion layer than in the case of horizontal fans blowing upward.

Again, the quantitative aspect makes these proposals unfeasible. For instance, it is estimated that a moderately large helicopter hovering would produce a jet immediately below it of velocity 20 meters per second over an area of about 250 square meters. (This change in momentum corresponds to the hovering of a helicopter weighing 12 tons.) Thus air would be brought downward at the rate of 5000 cubic meters per second, or 1.8×10^7 cubic meters per hour. If the diluting effect of this were complete, and if it were felt over 1 square kilometer when the inversion was at a height of 360 meters, the smoggy air would be diluted at the rate of 5 percent per hour. If we wish to attain a dilution of 50 percent—that is, reduce the concentration of pollutants by half—it would require ten helicopters per square kilometer. The cost of maintaining ten, or even one, helicopter hovering over each square kilometer of the basin is obviously unreasonable, and the noise and safety hazard would be more objectionable than the smog. Ground-based fans would have to be at least as dense, similarly costly and noisy, but probably considerably safer.

Utilization of Solar Energy

Since elimination of the inversion or blowing away the smog would require prohibitive amounts of energy if the energy has to be supplied in the form of fuel or electric power, proponents of eliminating smog by weather modification have looked to the possibility of utilizing natural sources of energy. The approaches most frequently proposed have been (i) more effective conversion of solar energy to eliminate the inversion or cause greater air movements and (ii) triggering some potential instability.

The proposals to use solar energy take various forms. Some examples are painting the roofs of buildings in alternate city blocks white and black in a checkerboard pattern to promote convection; paving large areas of the basin with black asphalt for the same purpose and to eliminate the inversion; introducing black carbon dust into the air over the basin at low levels so that the air in contact with it would be heated and would rise like balloons through the inversion; and using mirrors or lenses to concentrate the sunshine. I shall not take the space to analyze in detail the merits of all the various proposals. Instead, I shall discuss briefly the extent to which the sunshine is utilized naturally and the possibilities of increasing its utilization.

The problem of utilizing the solar energy more effectively consists of raising the proportion of it used to heat the air, ordinarily about one-third to one-half, by reducing the amount which is reflected, lost by long-wave radiation, used to heat the ground, or used in evaporation.

The various energy-transforming processes are interdependent. For instance, if the albedo of the ground is reduced so that less solar energy is reflected back to the sky, the conversion of the energy at the ground would raise the temperature at its surface and thus increase the radiation and evaporation from the earth's surface and the conduction of heat into its interior, as well as the heating of the air by conduction and convection. Similarly, changing the thermal conductivity or heat capacity of the ground, or both, or its water content available for evaporation, would affect the surface temperature, and thus the outgoing radiation. Only a part of the energy which it is intended to tap by these modifications would be utilized for reducing the inversion or promoting convection.

Table 2. Estimated average radiation-heat exchange at ground in September.

Hour (P.S.T.)	Accumulated energy (langleys) from sunrise to end of hour				
	Solar radiation	Net long-wave radiation	Conduction to ground and evaporation	Reflected from ground	Used to heat air
7 A.M.	6.2	6.7	2.5	1.2	−4.2
8 A.M.	24.3	13.7	9.5	4.9	−3.8
9 A.M.	58.0	21.1	20.2	11.6	5.1
10 A.M.	105.9	29.1	35.0	21.2	20.6
11 A.M.	164.6	37.5	51.3	32.9	42.9
12 noon	233.1	46.4	69.5	46.6	60.6
1 P.M.	305.2	55.6	89.0	61.0	99.6
2 P.M.	373.7	64.7	108.2	74.7	126.1
3 P.M.	432.2	73.7	125.5	86.4	136.6
4 P.M.	474.9	82.5	139.2	95.0	158.2
5 P.M.	498.3	91.0	147.7	99.6	160.0
6 P.M.	505.1	99.2	150.5	110.0	145.4

As an indication of the possibilities, Table 2 shows an estimate of the average radiational and heat exchange at the ground in September, which is the month of most probable low inversion and smog in Los Angeles. Results for other months would be similar.

In column 2 is shown the average radiation received on a horizontal surface in downtown Los Angeles from sun and sky at various times of day. It will be noted that, even apart from other processes, the 330 langleys which we found previously to be required for elimination of the inversion under average conditions is not received until about 1:30 P.M. Even if all the solar energy incident at the ground could be utilized to heat the air, the inversion would not be eliminated until after the time of maximum values of pollutant concentrations and smog effects over most of the basin.

In column 3 is presented the net radiational exchange between the ground and the atmosphere—that is, the (black body) radiation from the ground minus the energy radiated back to it from the water vapor and carbon dioxide in the air. The data were computed from the average 7 A.M. and 7 P.M. soundings at Long Beach, and from a synthetic 1 P.M. sounding arrived at by using the average downtown Los Angeles maximum temperature to establish the adiabatic lapse rate to the base of the inversion and interpolating between the Long Beach soundings for the rest of the sounding. The computations were carried out using the Elsasser radiation chart. The values for other hours were estimated by interpolation.

It is probable that any modification

designed to increase the atmospheric heating would also, by raising the ground temperature, increase the net outgoing long-wave radiation. Thus the available solar energy would always be reduced by at least the amount in column 3. This would result in elimination of the inversion occurring, at the earliest, at about 2:30 P.M., if all other energy losses were eliminated.

There are no available data on which to base a sound estimate of the average heat conducted into the ground (and buildings) or used in evaporation for the Los Angeles Basin. Homén's measurements for various surfaces in Finland suggest that, while the amount conducted into the soil and that used in evaporation separately vary greatly for rock, sand, meadows, and other surfaces, the total of the two is roughly the same for the various surfaces. This result is reasonable, for, wherever water is available for evaporation, the ground-air interface temperature is kept from rising, and thus the temperature gradient downward into the soil is smaller than it is in the absence of evaporation.

As a crude approximation of the amount of energy consumed by these two processes, the data cited by Sutton from Lettau's evaluation of measurements made by the Sven Hedin expedition were used, with slight adjustment, in column 4 of Table 2. The values are probably slightly high because of the high desert temperatures; a total of about 120 langleys for the 12-hour period might be more reasonable. However, the data obtained by Pasquill for a meadow in England were not significantly lower, and it was decided to use Lettau's data without further modification.

The average reflectivity of the complex of surfaces in the basin is likewise unknown. Measurements summarized in the Smithsonian Meteorological Tables for various kinds of surfaces occurring in the basin (grass, 14 to 33 percent; dry, plowed fields, 20 to 25 percent; sand, 18 percent) suggest that a value of 20 percent might be reasonable, and this value has been used for computing the values given in column 5. Subtracting the values in columns 3, 4, and 5 from those in column 2, we get the amount of energy available to heat the air, column 6.

The occurrence of the cessation of heating of the air between 4 and 5 P.M. appears to be inconsistent with the usual occurrence of the maximum temperature about 2 to 3 hours earlier. The occurrence of the sea breeze, which brings in air which has been over the ocean, may in part account for this discrepancy.

It has already been pointed out that, even if all the energy represented by columns 4 and 5 were utilized in heating the air, the inversion would not be eliminated before 2:30 P.M., considerably after the smog normally is swept away from downtown Los Angeles by the sea breeze. Obviously, a complete elimination of these "losses" is impossible. Only a part of the surface of the basin is subject to being painted black to reduce the reflectivity, or with an insulating material to reduce conduction into the ground. The lawns and gardens, forming part of the attraction of the area to residents and visitors alike, could not be covered with such surfaces without objections even greater than those which the smog has aroused. If, optimistically, one-half the losses were eliminated over one-half the area the air passes over in reaching downtown, the 25 percent saving would be inadequate to eliminate the inversion.

Recognizing that alteration of the entire surface of the basin is impractical, some people have proposed paving selected areas in it, to eliminate the inversion locally and allow the smog to escape through the "holes" thus created. Unless the areas were very large, comprising tens or hundreds of square miles, the air ordinarily would move off them before it was heated enough to eliminate the inversion.

A variant of this proposal has as its purpose the use of solar energy to cause greater horizontal movement of the air. If the sea breeze starts earlier or is stronger, for instance, the smog will not reach as high concentrations and will move out more quickly. To accomplish this, it has been proposed that the large canyons extending upward into the mountains be cleared of brush and paved with a nonreflecting and nonconducting substance. Clearing the brush and paving would reduce the frictional resistance to flow and at the same time increase the temperature, causing the up-slope winds to begin sooner and flow faster.

Again, quantitative considerations show that this effect at best would be a minor one. For every 1 meter per second that the sea breeze is increased on the average up to the inversion base, and for a 0.5-kilometer wide canyon, the total increase in air transport would be 10^9 cubic meters per hour, or less than 1/1000 of the air over the basin per hour. As in the case of the proposal regarding tunnels, it would require hundreds of such canyons, or, equivalently, hundreds of square miles of mountain slope to be cleared and paved to produce any considerable effect.

Triggering Potential Instability

We have seen that methods of adding energy or making better use of the natural energy input give little promise of ameliorating effects. The question arises, is there any possibility of releasing energy already in the system to produce the desired change? The answer, so far as the thermal stratification is concerned, is that the situation is extremely stable: there is no available potential energy. The large and extensive inversion is analogous to a cork raft on water, which bobs back into position no matter what the disturbance.

The wind distribution during smoggy periods, like the thermal distribution, contains no potential instability. Even at the time of maximum sea breeze, the wind shear through the inversion is very small, and during most hours the winds are light both below and above it. Thus there is no shearing instability to offset the thermal stability. With the warm layer above the cold, and with little or no kinetic energy available for redistribution, the possibilities are absolutely nil.

However, as has been pointed out by D. Van Ornum in proposals to the Air Pollution Foundation, there exists in the moisture distribution a possibility of altering this situation. The air above the inversion is so dry that, by evaporating water into it until it is saturated, it would be cooled to a potential temperature below that of the air below the base of the inversion. Van Ornum suggested that a string of fog nozzles be established along the mountains at, say, the 2000-foot contour. By saturating the air at this level, a downward flow of air would be induced which at night would increase the land breeze, and in the daytime offset the sea breeze, producing a continuous flow of air from land to sea. There are many interesting aspects of Van Ornum's proposal on which to speculate, such as the wind speeds which might be achieved during the day. For instance, it might turn out that the effect would be just sufficient to invert the normal regime, producing fairly rapid flow during the night and practically stagnation during the day. However, the economics of the proposal again make unnecessary the consideration of details.

The amount of water required may be estimated in various ways. Van Ornum's own estimates have varied from 6000 to 11,500 acre feet per day, which correspond to from 5 to 10 times the total water consumed by Los Angeles in a day. Obviously, even apart from the cost, such a large amount of water cannot be diverted to this purpose in a region of dire water scarcity. The possibility of using sea water has been mentioned. The problem of pumping this quantity of water from the sea to elevations of 2000 feet is not insuperable, though doubtless costly, but the problem of designing fog nozzles which would operate with sea water without corroding or clogging appears to be difficult indeed, and the effect of introducing into the air about 4×10^8 kilograms of salt per day might prove as objectionable as the pollution which we are attempting to remove. The visibility

would be greatly reduced, and the corrosive action of the air-borne salt would be great.

In addition to the problems involved in water supply, the cost of equipment and power would be tremendous. The height at which the fog nozzles would have to be mounted would depend on the drop size they are capable of producing. The smaller the drops, the less the height required in order to insure complete evaporation, but the more power required to break up the drops and the more nozzles required to produce the same volume of discharge. Even if towers only 100 feet high are required, the cost of constructing several per mile along the 2000-foot contour surrounding the basin, plus the cost of the spray nozzles, the water distribution lines, the pumping stations, and the electric power installations, could surely pay for the installation of equipment for controlling all the sources of pollution in the basin.

There have been other proposals to use water spray to wash and cool the smoggy air, in order to produce a film of clean cool air at the ground, say in the lowest 20 feet where most people are. On the one hand, the difficulties of scrubbing the pollutants, particularly the gaseous ones, even from air with higher concentrations of pollutants, suggest that the cleansing action of the spray would be partial at best. On the other hand, to the extent that the drops are large enough to reach the ground, carrying pollutants with them, the water is not evaporated to cool the air. Sufficient evaporation would be required to offset the solar heating at the ground, and it would have to occur uniformly over the entire area, or else convection would mix the "cleaned" air with polluted air above. Thus the water requirement would be even greater in this case than in Van Ornum's proposal.

Reducing the Insolation

As an alternative to the reduction or elimination of the reagents which participate in the photochemical reactions to form smog, it has been proposed that attempts be made to reduce the sunlight that causes the reactions. The concentration of oxidant, and presumably of other smog effects, appears to be directly related to the intensity of the shorter-wave solar radiation received at the ground. Leighton has studied this relationship (*7*). If the photochemically active portion of the sunlight were reduced sufficiently, the smog effects should be reduced below the noxious or nuisance thresholds.

A reduction of this type could be achieved by introducing an aerosol consisting of small droplets, which would scatter the sunlight, returning much of it back to the sky. The intensity of scattering depends on the drop size and the wavelength. For a given wavelength, there is a particular size of drop which maximizes the amount of scattering per mass of liquid suspended in the form of droplets. Short-wave sunlight is scattered most intensely by a given mass of oil of refractive index 1.5 if it is dispersed in drops with diameter in the range of 0.4 to 0.5 micron. Langmuir has suggested that smoke generators of the type which produce uniform drops of the required size be located along the western coast of the basin and operated for 5 or 6 hours from the time of the beginning of the sea breeze (9 A.M.). Assuming an average sea-breeze speed of 6 miles per hour, and about 15 miles of coast line, the area covered would be about 100 square miles, per hour. Langmuir has computed that about 10 gallons of Diol per square mile, or 1000 gallons (4 tons) per hour would reduce the intensity of sunlight 50 percent. My own computation indicates that the requirement is about 10 times this amount, but in either case the consumption of oil (24 tons per day, or 240 tons per day) would not be prohibitive if it were to produce the desired effect and no others.

The question whether a 50-percent (say) reduction of the insolation would necessarily eliminate the undesirable smog effects is a moot one. There have been days when fog and stratus clouds limited the total radiation for the day below this fraction, and yet severe eye irritation was experienced in some parts of the basin. The peak values of oxidant on these days were generally lower than on clear days, but this is not the only instance of lack of perfect correspondence between oxidant concentration and other smog effects. To settle the question, it might be worth experimenting with smoke screens, were it clear that this solution would be otherwise feasible and acceptable.

With respect to feasibility, the location of the smoke generators along the coast presupposes that air reaching all points in the basin with intense smog has entered across the west coast the same morning. Trajectory studies (*8*) have shown that, frequently, air arriving at sampling stations at times of peak concentrations of contaminants crossed the coast the previous afternoon and stagnated over the basin throughout the night. Furthermore, on some days in late fall, when some of the worst smog sieges occur, the winds are easterly during the day as well as at night. Thus, to handle all types of smog situations, the smoke generators would have to be dispersed widely, and the appropriate ones would have to be operated continuously for as much as 24 hours previous to times when conditions are expected to be favorable for smog.

Finally, the question of the acceptability to the community of this type of solution must be considered. Sunshine is one of the assets of the Los Angeles climate. Sacrifice of one-half of this asset, over and above the 10-percent reduction produced by the smog itself, will appear to most citizens as a last resort, to be taken only if it proves impossible to eliminate smog by control of the sources of the pollutants. Similarly, the severe reduction of visibility would meet with great objections. A blanket of white oil smoke would be no more attractive than the yellow-brown pall of smog to people who cherish the view of mountains and sea, and of "Catalina Island on a clear day." Langmuir states, "I have been in London during heavy fogs when the light intensity at noon was much less than it usually is at midnight, yet there was not the unpleasant irritation that exists in Los Angeles smog." But one would hope for a cure which would not so nearly resemble the ailment.

There have also been suggestions that the reaction might be inhibited by dispersal of some additional chemical agent into the air. No specific chemical has been proposed for this purpose, but at least one private organization has expressed willingness to accept a contract to explore the possibility. As in the case of other proposals, the advocates of this vague notion have succeeded in getting newspaper publicity which put pressure on the public agencies to divert funds from the direct attempts to control the sources of pollutants. Even though the Los Angeles County Air Pollution Control District has successfully (and in my estimation wisely) resisted these pressures, it has not been without cost in terms of time required to study each such proposal.

Conclusion

Unfortunately, most proponents of schemes to abate the smog by meteorological modification consider that they have done their share in coming forward with the general ideas, and that it becomes the duty of the county Air Pollution Control District or the private Air Pollution Foundation to work out details and conduct all necessary computations and experimental tests to demonstrate whether or not they are feasible and workable. When it is suggested that the proponents should carry out some feasibility computations on their own to see whether their ideas deserve serious consideration, they frequently reply with the charge that the "vested interests" have "negative attitudes" in their attack on the problem.

Such negative attitudes as exist in this

matter are based on familiarity with the situation and repeated computations of the type given here. Having examined many proposals, one is naturally reluctant to spend time on detailed study of another variant.

Only a completely new and unique approach to weather modification could have any hope of success in eliminating or ameliorating smog. Until such a unique approach has been demonstrated to be effective, it is reasonable for the agencies concerned with the solution of the problem to devote their undivided efforts to the detection and control of the sources of the pollutants responsible for the obnoxious and deleterious effects of smog.

References and Notes

1. *Smog*, originally a contraction of *smoke and fog*, has come to mean, generally, obnoxious concentrations of air pollution, and in Los Angeles specifically, the eye-irritating, plant-damaging, and visibility-reducing mixture which develops in the daytime on days of low inversion and light winds.
2. Much of the background work for this article was carried out while I was senior meteorologist at the Air Pollution Foundation, Los Angeles, Calif.
3. M. Neiburger, C. G. P. Beer, L. B. Leopold, *The California Stratus Investigation of 1944* (U.S. Department of Commerce, Weather Bureau, Washington, D.C., 1945).
4. M. Neiburger, *J. Meteor.* 1, 29 (1944).
5. L. A. Dubridge, *Engineering and Science* 19, 18 (1955).
6. O. G. Sutton, *Micrometeorology* (McGraw-Hill, New York, 1953).
7. P. A. Leighton and W. A. Perkins, *Solar Radiation, Absorption Rates, and Photochemical Primary Processes in Urban Air*. Report No. 14 (Air Pollution Foundation, Los Angeles, Calif., 1956).
8. M. Neiburger, N. A. Renzetti, R. Tice, *Wind Trajectory Studies of the Movement of Polluted Air in the Los Angeles Basin*. Report No. 13 (Air Pollution Foundation, Los Angeles, Calif., 1956).

R. Chambers, Pioneer in the Study of Living Cells

In the death of Robert Chambers in his 76th year, the scientific world has lost one of its most illustrious names. Biologists everywhere will be saddened, but many will call to mind his remarkable contributions to the study of living cells. Chambers was best known for his fundamental and enduring work on the biophysics of protoplasm. Many special problems and characteristics of plant and animal cells were resolved and made understandable by the use of microinstruments which he devised, improved, and logically exploited. To scholars of cellular physiology, his work on the structure of living membranes, capillary physiology, mesonephros function, fertilization problems in marine eggs, and adhesiveness of cancer cells in tissue culture remains classical. His astonishing development of the micromanipulator, along with the essential glass needles, micropipettes, electrodes, and microgages, stands as a landmark in the progress of science.

A contemporary and close friend of men like T. H. Morgan, E. B. Wilson, E. G. Conklin, and G. H. Parker, Chambers was nevertheless a *modern* man. It is to his credit that more than half of the program for the forthcoming International Congress for Cell Biology, in Scotland, is, almost prophetically, directly related to cellular studies in which he was at one time or another actively engaged. He furnished basic ideas for others to follow. His superlative services to biology and to science are, unfortunately, not so well known.

Born in Erzurum, Turkey, of Canadian missionary parents, he grew up in a deeply religious household and in the exciting atmosphere of Armenian-Turkish disputes. He is credited with having, as a boy, single-handedly interrupted a village massacre, preventing further bloodshed.

The prime quality of Chambers throughout his long life was his warm, human sympathy for his family, his students, and his host of friends in many lands. At his home, he and Mrs. Chambers entertained prince and pauper. No one was turned away. In a characteristic way he named his first cottage on the shores of Buzzards Bay "Bobtucket." His hospitality knew no bounds. His long associations with New York University, where he was research professor of biology, and with the Marine Biological Laboratory of Woods Hole, of which he was a trustee, enriched both institutions immeasurably.

This is not the place to review fully his education and early life at Robert College, Istanbul, or his later education at Queens University in Canada and at the University of Munich, where he became Richard Hertwig's favorite (and most famous) student. He belonged to one of the oldest German student corps, but he told me he never actually fought a duel! His numerous honors, positions, and accomplishments will be listed in the archives of many societies to which he belonged. Mention must, however, be made of his having been president of the American Society of Zoologists, the Harvey Society of New York, and the former Union of American Biological Sciences. In the latter group his efforts led directly to the formation and establishment of the present American Institute of Biological Sciences. He was a founder of the Society of General Physiologists. With Josef Spek, he founded and edited the journal *Protoplasma*. He was an active member of the committee of scientists that persuaded the United States Congress to set up the National Science Foundation. As senior scientific adviser to the New York World's Fair, his laboratory provided free motion pictures of living cells that attracted the largest number of public visitors of any educational exhibit. It is noteworthy that he was the chief spirit in the renaissance of the New York Academy of Sciences that led to its present prestige and fame.

Chambers loved adventure, he loved his family, but above all he loved the eternal search for scientific truth. To him, religion and science were indivisibly one. While it it true that he also knew personal tragedy and felt the slings and arrows of outrageous fortune and the discouragements of seeking almost parsimonious research-grant support, it is nevertheless true that his life was a deeply happy one. Indeed, the monuments to his career are the basic facts he discovered, the achievements of his students, the flourishing of the societies, journals, and ideals which he literally built with his own brilliant intellect, and the profound respect and admiration of his world-wide circle of friends and fellow-scientists.

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News of Science

Cold Vaccine

On 19 Sept., Winston H. Price announced the development of a vaccine for one strain of the common cold. The virus is the JH virus (for Johns Hopkins), which Price isolated 4 years ago and which, in a 2-year study, he found to cause 30 percent of the cold cases examined. The vaccine proved to be 80 percent effective in treating the JH virus, and the work has been confirmed by three other laboratories.

Price, who is working under a grant from the Rockefeller Foundation, is an associate professor of epidemiology and biochemistry and director of the division of ecology at the Hopkins School of Hygiene and Public Health. In 1954 he won the Theobald Smith Award in the Medical Sciences, which is awarded annually by the AAAS. An article by Price, describing his work, is scheduled to appear in the September proceedings of the National Academy of Sciences. The full text of the article was published in the *New York Times* of 19 Sept. Here is Price's summary.

"1. The JH virus was found in association with an upper-respiratory outbreak in children.

"2. Children given a vaccine prepared from inactive JH virus showed an attack rate about 8 times lower than that of the children receiving the placebo injections.

"3. No untoward reactions were observed in 401 individuals receiving the vaccine, which was prepared from inactivated JH virus grown in monkey kidney epithelial tissue.

"4. It is concluded that the JH virus is the cause of the cold-like illness in humans and that an inactivated vaccine can be prepared from the virus which protects against the overt illness due to the JH virus."

Research and Freedom

In a recent article in the *Bulletin of the Atomic Scientists,* Stevan Dedijer, Yugoslav nuclear physicist, declared that what he called "underdeveloped countries" should seek a "persistent development of a general atmosphere of freedom" and that each should "take a mercilessly critical, objective look at itself and its new ideology from all angles." It appears from Dedijer's description of underdeveloped countries as "countries that have recently gained their independence and are experimenting with all kinds of social systems," that he is talking about Yugoslavia.

Dedijer fails to see anything of an imperialist plot in freedom of communication. Such freedom is "but a social mechanism developed by the 'capitalist imperialists' for their own good and essential for modern society." He also fails to see the Soviet Union's success in developing nuclear weapons as proof of the relative inefficiency of the democracies. Soviet secrecy about research may hide unnecessary waste, he maintains.

Stevan Dedijer studied in the United States at Princeton University, and served in the United States Army during World War II. He is now in Yugoslavia with the Rudjer Boshkovich Institute at Zagreb.

Rice Disease in Florida

A disease of rice that may be capable of seriously damaging the country's $200-million rice crop has been discovered at Belle Glade, Fla., just southeast of Lake Okeechobee, according to a joint announcement made 18 Sept. by the U.S. Department of Agriculture and the Florida Plant Board. Very little research has been done so far on the disease, *hoja blanca,* either in the United States or in other countries. The disease has been under observation for the past few years in Cuba and Venezuela. Until the recent discovery, the disease was not known to occur in the United States.

Rice plants and possibly certain grass weeds are infected by the disease in the Belle Glade area. Whether the disease may affect other grains or grasses is not known. Weeds that showed evidence of possible attack by the disease included barnyard grass (*Echinochloa colonum* or *E. crusgalli*) and *Panicum fasciculatum,* a weed related to millet. Unlike rice, these apparent hosts of the disease grow widely throughout Florida and other southern states. (Rice is produced commercially in Arkansas, Louisiana, Mississippi, Texas, and California.) Symptoms of the disease include yellowish-white discoloration or streaking of the leaves; the plants often fail to head.

Arrangements have been made (i) to spray with insecticide all the infected areas found so far, as a means of destroying suspected insect carriers of the disease; (ii) to plow under all infected rice in these areas; and (iii) to destroy infected grasses with chemical weed-killer. The destruction of all plants in the Florida areas where *hoja blanca* has so far been discovered is expected to be completed soon.

How *hoja blanca* got into this country is not known. It is believed to be caused by a virus and to be spread by insects, probably leaf hoppers. Early this year, an entomologist of USDA's Agricultural Research Service began investigations in Cuba to determine the particular insect or insects that may be responsible for spreading the disease. So far as Department scientists know, *hoja blanca* is not seed-borne, and they discount the possibility that it might have been brought in by imports from Cuba. Plant-quarantine regulations specifically forbid importation of rice and riceplant materials from disease-infested areas.

About 4000 varieties and strains of rice from the USDA's world rice collection have been grown where the *hoja-blanca* virus is epidemic in an effort to discover plant resistance. So far, some 285 lines of short- and medium-grain rice have been found with appreciable resistance to the disease. Most of these lines are introductions from Japan, China, and Formosa. Although none of the resistant lines so far discovered is equal in commercial acceptability to varieties now grown, some of them might serve in an emergency. They will also be used as breeding material for crossing with U.S. commercial varieties in an effort to produce new high-yielding, disease-resistant varieties.

No varieties of long-grain rice—especially important to southern U.S. growers—have been found with resistance to *hoja blanca.* However, time of planting is known to affect the susceptibility of rice plants to the disease, and there is a possibility that a shift in planting dates could permit the growing of present rice varieties even when *hoja blanca* is present. To test this possibility, year-round planting studies with five commercial varieties of U.S. rice have been under way in Cuba since the fall of 1956. These include the long-grain varieties, Bluebonnet 50, Century Patna 231, and Toro, and the medium-grain varieties Nato and Zenith.

All additional varieties and strains of rice in the USDA world collection not previously tested—including some 3000 entries—will be planted in Cuba and

Venezuela next spring. At that time, late in the planting season, rice seems to be most susceptible to *hoja blanca,* and the test for disease resistance is therefore likely to be more conclusive.

Atomic Post Filled

President Eisenhower has appointed Robert M. McKinney to represent the United States on the International Atomic Energy Agency, which was organized to carry out the President's Atoms for Peace program of 1953. McKinney, a Santa Fe, N.M., publisher, served as chairman in 1955 and 1956 of a panel on the impact of the peaceful uses of atomic energy. A Democrat, he supported Adlai E. Stevenson in the last Presidential campaign.

The appointment, which was made over Republican protests, is subject to Senate confirmation in January. When the impending appointment became known before Congress adjourned, Senator William F. Knowland (R.-Cal.) and Meade Alcorn, Republican national chairman, announced their displeasure. There may be a tough fight in the Senate over confirmation, but McKinney can expect strong support from Senator Clinton P. Anderson (D.-N.M.), who exercises considerable influence in the joint House-Senate Committee on Atomic Energy.

Chemical Society Building

The American Chemical Society will open this fall a $3-million drive for funds to build a new eight-story national headquarters on the site of the society's present building at 1155 16 St. N.W., Washington, D.C. The society's headquarters staff, which numbered 29 when the present building was acquired, now totals 204.

Besides offices, the new building will have a library, a meeting room seating 250 persons, accommodations for committee meetings, and a lobby large enough to make possible educational displays of interest to Washington visitors. Faulkner, Kingsbury, and Stenhouse are the architects. Plans have been approved by the Zoning Board of the District of Columbia.

More Nuclear Tests

The Atomic Energy Commission and the Department of Defense plan to begin a new series of nuclear tests in April 1958 at the Eniwetok Proving Ground in the Pacific to advance the development of weapons for defense against aggression, whether air-borne, missile-borne, or otherwise mounted. Test operations will be governed by the declaration made in the Bermuda communique on 24 March 1957 of the intention of the United States "to conduct nuclear tests only in such manner as will keep world radiation from rising to more than a small fraction of the levels that might be hazardous."

An important objective of the tests will be the further development of nuclear weapons with greatly reduced radioactive fallout so that radiation hazard may be restricted to the military target. A United Nations agency will be invited to designate an international group to observe one of the detonations involving limited fallout, and studies are under way to determine the instrumentation which will facilitate their observation without making disclosures that would compromise restricted weapon information.

Radioisotopes Training for Latin America

The University of Puerto Rico has established a Radioisotope Techniques Training Center following a pattern similar to the Special Training Division of the Oak Ridge Institute of Nuclear Studies. This center is financed by the Atomic Energy Commission with the purpose of providing training in radioisotope techniques for Latin American scientists. The dates for the courses that will be offered during the rest of the academic year are as follows: 4 Nov.–29 Nov. 1957; 6 Jan.–31 Jan. 1958; 3 Mar.–28 Mar. 1958; and 5 May–30 May 1958. For further information write to: Director, Centro de Entrenamiento en al Manejo de Radioisótopes, Universidad de Puerto Rico, Río Riedras, Puerto Rico.

IGY Data Exchange

There is evidence that both Soviet and Western scientists who are participating in the International Geophysical Year are withholding scientific information, according to Walter Sullivan's report in the *New York Times* on 17 Sept. Much of the success of the work during the IGY depends on the free exchange of information among the participating countries, because in many cases scientific observations from one place on the earth's surface will have little meaning until they have been coordinated with observations from other places.

Most Western scientists agree that the Soviets have been giving information more freely than in the past. In fact, a Soviet scientist recently lent an American scientist some unpublished maps that gave valuable data bearing on studies of the earth's structure. Nevertheless, in those fields that might be considered to border on the military, little data has been forthcoming from Soviet scientists.

Western scientists also appear to be holding back information. The reason is not because the data must be kept secret, but to provide a bargaining point in efforts to get the Soviet scientists to release comparable information. One instance of withholding data concerns the results of a recent survey that serves to correct present information about the relative positions of Europe and North America.

Reactor School

The Atomic Energy Commission has accepted 62 scientists and engineers, 50 of them from 21 foreign countries, for enrollment in the sixth session of the commission's International School of Nuclear Science and Engineering at Argonne National Laboratory, Lemont, Ill. A part of the President's Atoms for Peace program, the training session is shared by the International School, North Carolina State College, and Pennsylvania State University.

The enrollment brings to 355 the number of scientists and engineers pursuing the course in unclassified reactor technology. Of these, 267 have come from 42 foreign countries. The 88 American students have been sponsored largely by United States firms interested in nuclear energy.

News Briefs

Humble Oil and Refining Company's Refining Research and Development Division is occupying a newly completed extension to its main laboratory building at the Baytown, Tex., Research Center. The 27,000-square-foot expansion provides a 70-percent increase in laboratory space and about a 40-percent increase in office space. The extension will house research personnel who formerly occupied space in other buildings and will provide for expansion in the staff. The building provides facilities for research in petroleum refining and petrochemical development.

* * *

Bjorksten Research Laboratories for Industry, Inc., Madison, Wis., has announced the opening of its new Houston, Tex., laboratory for sponsored industrial research. Luther L. Yaeger, vice president, will be in charge.

* * *

Stockholders of Schering Corporation and White Laboratories, Inc., voted on 19 Sept. to merge the two firms into a single pharmaceutical company. The

merger became effective immediately; Schering is the surviving corporation. White Laboratories and its subsidiary, Pharmaco, Inc., will continue to operate under their present names. The activities of Schering's proprietary drug subsidiary, Union Pharmaceutical Co., will be merged with those of Pharmaco.

* * *

A program totaling $25,000 in agricultural grants-in-aid at ten universities and two independent research foundations will be sponsored by the Climax Molybdenum Company during 1957–58. Under this program, agricultural and biological research projects will be conducted on molybdenum as a trace element in an effort to compile additional data on its effect on plant life. Climax has sponsored programs in agricultural research for the past 8 years.

* * *

Controls for Radiation, Inc., is a new firm in Cambridge, Mass., that will provide a comprehensive "package" service covering the broad radiation safety and hazards control aspects of the nuclear industry. William E. Barbour, Jr., founder and former president and chairman of Tracerlab, Inc., is president of the new corporation, and Irving A. Berstein is vice president and technical director.

* * *

CBS Laboratories, New York, has announced that a new laboratory will be built in Stamford, Conn. The completed project will cost in excess of $1 million and is expected to be ready for occupancy in the summer of 1958.

Inorganic Chemicals

The Commission on Inorganic Nomenclature of the International Union of Pure and Applied Chemistry has officially adopted the following symbols for chemical elements: Ar, argon; Es, einsteinium; Md, mendelevium; and No, nobelium. The commission has now completed the revision of the 1940 rules for the naming of inorganic chemicals.

Zoological Nomenclature

The International Commission on Zoological Nomenclature has announced that beginning 30 Mar. 1958 it will start voting on the following cases involving the possible use of its plenary powers for the purpose specified against each entry. Full details of these cases will be published on 30 Sept. in the *Bulletin of Zoological Nomenclature* (vol. 13, pt. 9): (i) *Phrynosoma* Wiegmann, 1828, validation (cl. Reptilia, order Squamata); (ii) *Pentila* Westwood, [1851], validation, and designation for, and for *Liptena* Westwood, [1851], of type species (cl. Insecta, order Lepidoptera); (iii) *Centris* Fabricius, 1304, designation of type species for; *dimidiata* Fabricius, validation (cl. Insecta, order Hymenoptera); (iv) *adspersus* Rathke, 1837 (*Palaemon*), protection (cl. Crustacea, order Decapoda).

A proposal has also been made for the adoption of a "declaration" on the question of the use of the diaeresis sign for zoological names. Comments should be sent as soon as possible, in duplicate, to the secretary of the commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1, England.

Stricter Exposure Rules

The Atomic Energy Commission may adopt this fall new standards for permissible levels of radiation, to be based on the recommendations of the National Committee on Radiation Protection and Measurement. The recommendations, which for the first time establish standards for average levels of exposure over a period of years, provide standards both for workers in atomic installations and for the population outside atomic installations.

Atomic workers may receive at most an average of 5 rem a year, but as much as 15 rem in any one year. (The rem is defined as a dose of radiation equal in its biological effects to 1 roentgen of high-voltage x-radiation.) The outside population may receive one-tenth this exposure.

Under present AEC standards, instead of a maximum of 60 rem in a 12-year period, atomic workers may receive a total of 180 rem. The outside population may receive up to 1.5 rem a year. However, the levels that have actually been observed by the AEC in its own atomic installations lie within the new standards.

The new standards are planned because of the trend exhibited in recent scientific research. Although the exact effects of radiation on heredity and longevity may not be known for many years to come, evidence is accumulating that continuous low levels of exposure may be dangerous.

One consequence of stricter standards may be an adverse effect on the infant atomic industry, for the requirement of greater safety measures will drive costs up.

Advanced Study

The Public Health Service has announced a new program of financial support for advanced training of research scientists in neurological and sensory disorders, to be conducted by the National Institute of Neurological Diseases and Blindness, Bethesda, Md.

A previous program, under which about 75 scientists received advanced training during the last fiscal year, was concerned exclusively with clinical training. The new program will also cover such basic sciences as neurochemistry, neuropharmacology, neurophysiology, and neuroanatomy.

Awards will be made for periods of 9 months to 1 year, with possible renewals of 3 years. Stipends may range from $5500 to $14,800 a year.

Applicants must have completed either (i) the residency training requirements in a clinical specialty, or its equivalent, or (ii) at least 3 years of pertinent postdoctoral training or research experience. For information write to the Chief, Extramural Programs Branch, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda 14, Md.

Scientists in the News

CYRIL L. COMAR has been named director of the new laboratory of radiation biology at the Veterinary College of Cornell University, Ithaca, N.Y. Comar was formerly chief of biomedical research at Oak Ridge Institute of Nuclear Studies.

C. G. GOODCHILD, professor of biology at Emory University, has been appointed chairman of the department. He succeeds W. D. BURBANCK, who resigned the position and will be on leave of absence from the department during 1957–58. Burbanck's address for the year will be the Marine Biological Laboratory, Woods Hole, Mass.

ALBERT S. HUNTER, former senior soil scientist with the Agriculture Research Service, U.S. Department of Agriculture, and Oregon State College, has been appointed professor of soil technology in the agronomy department of Pennsylvania State University.

The American Society for Metals has announced that the following awards will be made during the society's 39th National Metals Exposition and Congress, which is to be held in Chicago, Ill., 2–8 Nov. 1957.

JOHN CHIPMAN, head of the metallurgical department, Massachusetts Institute of Technology, will receive the Gold Medal and Senior Award for his teaching and research.

ROY C. McKENNA, chairman of the board of Vanadium Alloys Steel Company, Latrobe, Pa., will receive the Gold Medal for the Advancement of Research.

TOKUSHICKI MISHIMA, profes-

sor emeritus at the University of Tokyo, will receive the Albert Sauveur Achievement Award for his work on strong permanent magnets.

JOSEPH B. QUIG, formerly research manager of fibers at E. I. du Pont de Nemours and Company, Inc., Wilmington, Del., has joined Lowell Technological Institute as associate professor of chemistry.

WALTER E. LOOMIS, professor of plant physiology at Iowa State College, has returned from a year spent as agricultural adviser with the International Cooperation Administration in the Middle East.

FREDERICK GUDERNATSCH, who retired in 1945 from active teaching and who is now in charge of the Arctic Aeromedical Bibliographic Service at Cornell University Medical College, recently received an honorary degree from the University of Giessen, Germany, on the occasion of its 350th anniversary. He was honored for his research in endocrinology, especially in the physiology of the thyroid gland.

WARREN E. SNYDER, senior research engineer and supervisor of fluid dynamics in the gas turbine department, General Motors Research Staff, Detroit, Mich., has been appointed manager of the Engineering Division of Midwest Research Institute, Kansas City, Mo.

KENNETH W. SPENCE, head of the psychology department at the State University of Iowa, CARL R. ROGERS, professor of psychology at the University of Chicago, and WOLFGANG KOHLER, professor emeritus at Swarthmore College, Swarthmore, Pa., have been named recipients of the American Psychological Association's Distinguished Scientific Contribution Award.

JOHN J. FLAHERTY has resigned from his post as manager of the Chicago Operations Office of the Atomic Energy Commission. He will become assistant to the general manager of Atomics International, a division of North American Aviation, Inc.

VICTOR C. VAUGHAN, III, former associate professor of pediatrics at Temple University School of Medicine, has been appointed professor and chairman of pediatrics at the Medical College of Georgia.

HEIKKI V. TUOMINEN, formerly chief geologist for the Finnish Ore Company, Helsinki, Finland, has been named associate professor of geology at Lehigh University.

ALAN C. WOODS, professor emeritus of ophthalmology at Johns Hopkins University, will go to the International Congress of Ophthalmology in Brussels, Belgium, next year to receive the 1958 Gonin medal, perhaps the highest honor in the field of ophthalmology.

The medal was established to honor the memory of Dr. Jules Gonin, the Swiss ophthalmologist who developed the technique for repair of detached retinas. Woods is the first American to have been selected for the award since it was set up 20 years ago.

VICTOR A. PHILLIPS, a metallurgist who for the past 2 years has been a member of the faculty at the University of Sheffield in England, has been named to the staff of the General Electric Research Laboratory, Schenectady, N.Y.

RELIS B. BROWN, formerly at Lawrence College, will be visiting associate professor of biology at Vanderbilt University for the academic year 1957–58.

The following scientists will direct the International Geophysical Year projects in Antarctica for the next 18 months: MATTHEW BRENNAN will be in charge of the Ellsworth Station, STEPHEN BARNES will head the Byrd Station, WILLIS TRESSLER will direct the Wilkes Station, and PALLE MOGENSON will be in charge of the Amundsen-Scott Pole Station. HARRY WEXLER will continue as chief scientist, and ALBERT P. CRARY will remain as station scientific leader at Little America and will continue to serve as deputy chief scientist.

EDWARD R. WOODWARD, former associate professor of surgery at the University of California at Los Angeles, has been appointed professor of surgery and head of the department of surgery at the University of Florida College of Medicine. Woodward is a specialist in clinical work and in the physiology of the gastrointestinal tract.

SHARAT K. ROY, chief curator of geology at Chicago Natural History Museum, has begun a 10-month survey of the world's important meteorite collections. He will proceed first to London and Paris, and then to Frankfort, Vienna, Helsinki, Calcutta, and perhaps to Moscow.

THOMAS L. AUTH, chief of the neurology service at the Veterans Administration Hospital in Washington, D.C., has been appointed chief of the neurology division at the VA's central office in Washington. He succeeds BENEDICT NAGLER, who left the Veterans Administration on 8 Sept. to become superintendent of the Lynchburg Training School and Hospital at Colony, Va.

ROBERT S. TIPSON, former senior fellow at the Mellon Institute, Pittsburgh, Pa., has joined the organic chemistry section of the National Bureau of Standards.

BERNARD GREIFER, former member of the Pittsburgh physical research section of the U.S. Bureau of Mines, has joined the staff of the Kinetics and Combustion Group at the Atlantic Research Corporation, Alexandria, Va. Greifer will conduct fundamental and applied research in gaseous and solid combustion processes.

ALBERT I. SCHINDLER of the Naval Research Laboratory has been awarded the laboratory's E. O. Hulburt Award for his contributions to the field of metal physics, particularly his interpretation of the measurements made on the electron transport properties of the nickel-palladium series. This interpretation led to an understanding of certain ferromagnetic phenomena in alloys. The $300 Hulburt Award was established in 1955 in honor of the laboratory's first director of research on the occasion of his retirement.

Recent Deaths

CHARLES W. CRAWFORD, San Francisco, Calif.; 68; retired commissioner of the U.S. Food and Drug Administration; considered by many to be the father of the present Food, Drug, and Cosmetic Act; 15 Sept.

ELIZABETH I. PARSONS, Atlanta, Ga.; 62; bacteriologist; head of the general diagnostic bacteriology unit of the laboratory branch of the Communicable Disease Center of the U.S. Public Health Service; 6 Sept.

TIMOTHY J. RIORDAN, New York, N.Y.; 62; chief attending dermatologist at St. Vincent's Hospital; clinical professor of dermatology at New York University–Bellevue Medical Center; chairman of the dermatology section, New York Academy of Medicine; attending dermatologist at New York Foundling and St. Elizabeth hospitals, associate dermatologist at Bellevue Hospital, and consulting dermatologist at Lutheran Hospital, Bayonne (N.J.) Hospital, and St. Joseph's Hospital of New York; 17 Sept.

ELIAS SEDLIS, New York, N.Y.; 68; gynecologist; medical director of the Jewish Municipal Hospital in Wilno, Poland, and chief of its gynecology department until 1939; founder of the Society of Jewish Physicians in Italy; came to this country in 1949, but never practiced here; 12 Sept.

Reports

Selective Removal of Nonprotein Sulfhydryl Compounds from Biological Systems

Many important biological systems depend on sulfhydryl groups for their function. Maintenance of a balanced oxidation-reduction system is of great importance, and a reservoir of readily oxidizable thiols such as glutathione is frequently necessary to protect the sulfhydryl groups on various enzymes and other proteins. In the course of experimentation, however, it is often desirable to deplete this reservoir. The sulfhydryl groups of the reservoir may be inactivated by the use of iodosobenzoate, chloromercuribenzoate, or N-ethyl maleimide, but these agents have an affinity for the sulfhydryl of enzymes as well as for the sulfhydryl of glutathione. Hence, the selective inactivation of nonprotein sulfhydryl groups is often impossible. This problem was encountered during our studies on the relationship of glutathione to adrenal cortical function, and a technique was devised which may find wide application (*1*). Its basis is to render chloromercuribenzoate insoluble, so that it may be enclosed in a dialysis casing and used to trap the sulfhydryl compounds of low molecular weight which dialyze out of a solution or suspension of proteins.

It was found that sodium *p*-chloromercuribenzoate could be tightly bound by its carboxyl group to Dowex 2-X resin, 25–50 mesh, leaving the mercury end free. The resin was first converted to the chloride form, then placed into a small flask surmounted by a filter funnel. Into another flask was weighed a quantity of sodium *p*-chloromercuribenzoate (*p*CMB) crystals in 25 percent excess of the milliequivalents represented by the weight of resin. Water was added to the highly insoluble *p*CMB crystals, and the flask was shaken for a few minutes. After the undissolved crystals had been allowed to settle, the supernatant was poured through the funnel onto the resin, which was stirred continuously with a magnetic stirrer. After a minute or two, the aqueous supernatant was poured back into the flask containing the *p*CMB crystals. It is of greatest importance to avoid any contact between the resin and crystals. This procedure was repeated until the resin supernatant showed the presence of excess *p*CMB. This was determined by adding 0.5 ml of supernatant to 0.5 ml of a standard solution of glutathione (9.3 mg/100 ml) and measuring the resulting concentration of glutathione by amperometric titration (*2*). The process was continued until there was no further uptake of *p*CMB. Ninety to 92 percent of the theoretical amount of *p*CMB was eventually bound to the resin.

Stability studies with the *p*CMB-resin showed no change in sulfhydryl-combining power after the solution was shaken with 1.0*N* HCl or 1.0*N* NaOH. Storage in distilled water at 4°C for periods up to 60 days, storage for several days at room temperature, or drying out of the resin had no effect on its activity as long as it was kept in the dark. The presence of tetrasodium ethylenediamine tetraacetate in the test solution did not affect sulfhydryl-binding capacity.

A small dialysis bag containing 8 g of *p*CMB-resin was placed in a vial with 45 ml of a sulfosalicylic acid extract of rat liver, and the vial was sealed and shaken mechanically at about 30 oscillations per minute. Hourly amperometric titration of an aliquot of filtrate showed that 40 percent of the liver sulfhydryl was removed in 4 hours and that 93 percent was removed in 6 hours. In another experiment a homogenate of rat liver was prepared in saline. A portion of this homogenate was boiled briefly and filtered through paper. The dialysis bag was filled with 500 mg of *p*CMB-resin, and the residual air was displaced with boiled filtrate. The bag was then placed in a small screw-cap vial containing 1.0 ml of liver homogenate to which had been added 114,000 count/min of S^{35}-radioglutathione. A series of such vials was placed in a tubular incubator rotating on its long axis at 13 rev/min. At intervals, small aliquots of homogenate were removed and treated with 10-percent sulfosalicylic acid; the radioactivity of the extract was measured by liquid scintillation counting (*3*).

In several trials, an average of 26.5 percent of the radioactivity was removed in 30 minutes, 37 percent in 60 minutes, and 46.5 percent in 90 minutes. Longer dialysis times were not investigated. From these data it is evident that dialyzable sulfhydryl compounds can be selectively removed from tissue homogenates or other protein-containing media.

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References and Notes

1. This investigation was supported in part by a research grant (A-451) from the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, U.S. Public Health Service.
2. J. W. Goldzieher, W. B. Rawls, M. A. Goldzieher, *J. Biol. Chem.* 203, 519 (1953).
3. J. W. Goldzieher, P. K. Besch, M. E. Velez, in preparation.

13 May 1957

Elution of Chromium-51 from Labeled Hemoglobins of Human Adult and Cord Blood

The erythrocyte of the newborn infant apparently has the same life-span as, or possibly one slightly shorter than, that of the adult, as determined by the method of differential agglutination (*1*, *2*), but measurements with Cr^{51}-labeled red cells seem to indicate a much shorter life-span (*3*). It has been pointed out by Mollison (*2*) that this apparent discrepancy may

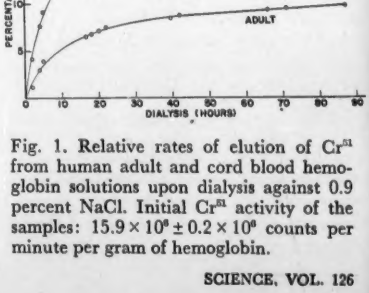

Fig. 1. Relative rates of elution of Cr^{51} from human adult and cord blood hemoglobin solutions upon dialysis against 0.9 percent NaCl. Initial Cr^{51} activity of the samples: $15.9 \times 10^6 \pm 0.2 \times 10^6$ counts per minute per gram of hemoglobin.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

be due to a difference in the rates of elution of Cr^{51} from the cells.

Since the labeling of erythrocytes with Cr^{51} involves attachment of the metal to hemoglobin (*4*), and since the hemoglobins of normal adult red cells (mainly hemoglobin A, *5*) differ markedly from the predominating hemoglobin (hemoglobin F) in the red cells of the newborn (*6*), it was decided to determine whether a difference exists in the ability of the respective hemoglobin to retain the Cr^{51} label.

Erythrocytes, obtained from the blood of normal adults and from the umbilical cord of normal full-term infants, were washed with saline to remove plasma proteins, then resuspended in suitable volumes of saline to bring the hemoglobin concentrations to the same level (about 12 g percent). Equal volumes (5 to 15 ml) of the two types of washed cell suspensions were incubated with equal amounts of radioactive Cr^{51} (280 to 980 μc as $Na_2Cr^{51}O_4$) for about 2 hours at 37°C. The labeled cells were repeatedly centrifuged and washed, with one or two prolonged periods (3 to 24 hours) of contact between cells and saline, till the supernatants exhibited a very low degree of radioactivity, as measured in a well-type scintillation counter. After removal, by this means, of essentially all unbound Cr^{51} from the cells, the latter were hemolyzed by the addition of 1 vol of water and 0.4 vol of toluene. After centrifugation to remove stroma, the concentration and radioactivity of the clear hemoglobin solutions were determined. Suitable aliquots containing approximately equal amounts of the Cr^{51} label were subsequently dialyzed over periods of time ranging from 65 to 213 hours against 12 or more changes of saline, each of 100 ml. The radioactivity of the dispersion medium was finally measured, and appropriate correction was made for decay of the isotope.

Under strictly comparable experimental conditions, an unequivocal difference was evident in the rate at which Cr^{51} was eluted from the two types of hemoglobin solutions. In a typical experiment (Fig. 1), the percentage of the isotope eluted from cord blood hemoglobins after 87 hours of dialysis was 2.3 times that eluted from adult hemoglobin, whereas the amount of Cr^{51} bound per unit concentration of hemoglobin was approximately the same. In these experiments, the ratio of percentage of Cr^{51} eluted from cord hemoglobins to percentage of Cr^{51} eluted from adult hemoglobins ranged from 2.0 to 2.9. Variations in the absolute percentages of chromium eluted (ranging from 17 to 27 percent of the total for cord and from 5.9 to 13.5 percent for adult) did not affect the net results. Most of the elution, moreover, occurred during the first 24 to 37 hours of dialysis, confirming the work of Gray and Sterling (*4*).

Whether or not the hemoglobins show the same differentiation in the intact red cell is still uncertain, but the results reported here lend indirect support to Mollison's suggestion that much of the difference in survival rates of red cells of the adult and of the newborn, as determined with Cr^{51}, is only apparent. It is probable that molecular differences in these hemoglobins are responsible. This aspect and its implications for thalassemia (Hb F) and other hemoglobin diseases are receiving further attention (*7*).

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References and Notes

1. K. Seelemann, *Z. Kinderheilkunde* 75, 189 (1954).
2. P. L. Mollison, *Blood Transfusion in Clinical Medicine* (Thomas, Springfield, Ill., 1956), p. 140.
3. J. W. Hollingsworth, *J. Lab. Clin. Med.* 45, 469 (1955).
4. S. J. Gray and K. Sterling, *J. Clin. Invest.* 29, 1604 (1950).
5. H. G. Kunkel and G. Wallenius, *Science* 122, 288 (1955).
6. H. A. Itano, *ibid.* 117, 89 (1953); J. C. White and G. H. Beaven, *J. Clin. Pathol.* 7, 175 (1954); A. I. Chernoff, *New Engl. J. Med.* 253, 322 (1955); R. Lemberg and J. W. Legge, *Hematin Compounds and Bile Pigments* (Interscience, New York, 1949).
7. We wish to express our thanks to the National Cancer Institute of Canada for funds to purchase Cr^{51} (Abbott sodium radio-chromate) and to H. Blondal and G. E. Delory for help and advice.

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Reversal of Virus-Caused Stunting in Plants by Gibberellic Acid

Reports on the use of gibberellic acid in overcoming genetic (*1*) and physiologic (*2*) dwarfism suggested testing whether it could induce growth of plants stunted by certain virus diseases. Three leafhopper-borne viruses that cause severe stunting in susceptible plants were chosen for the experiment. Corn stunt virus of the Mesa Central strain (*3*) was inoculated into seedlings of hybrid sweet corn, *Zea mays*, of the variety Country Gentleman, by means of viruliferous *Dalbulus maidis*. The Eastern strain of aster yellows virus was introduced into seedlings of China asters, *Callistephus chinensis*, by the leafhopper *Macrosteles fascifrons*. Wound tumor virus was transferred to seedlings of crimson clover, *Trifolium incarnatum*, by *Agalliopsis novella*. Six weeks after inoculation, severely stunted plants were grouped according to size and sprayed with a freshly prepared water solution of gibberellic acid at 100 ppm (*4*). A control group of similar sized plants was sprayed with distilled water. Both groups were maintained on the same greenhouse bench.

Gibberellic acid was reapplied twice, at weekly intervals. The striking effect of the treatment is shown in Figs. 1–3. The photographs were taken 1 week after the last application. The treated plants had resumed growth, while diseased controls had remained stunted. The internodes of yellowed asters and stunted corn elongated to twice the original length, while the clover petioles increased 3 times in length and assumed an erect position during the 4-week period. In corn, the reversal of stunting became visible 48 hours after the first application, while in asters and clover it was noticed only after 5 days.

It is apparent that, under the conditions of the test, gibberellic acid influenced significantly the growth of virus-stunted plants. Although stunting could be overcome to a considerable degree by three applications of gibberellic acid, diseased plants retained other signs of virus infection. Leafhopper vectors were

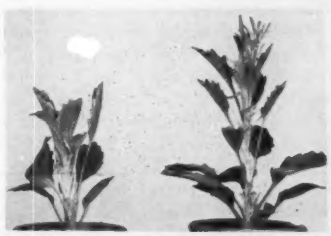

Fig. 1. China asters infected with aster yellows: (left) untreated control; (right) treated with gibberellic acid.

Fig. 2. Hybrid sweet corn infected with corn stunt: (left) untreated control; (right) treated.

Fig. 3. Crimson clover with wound tumor: (left) untreated control; (right) treated. [Photos for Figs. 1–3 by J. A. Carlile]

able to recover the respective viruses from plants treated with gibberellic acid as readily as from untreated controls. Further studies will be directed to explain the mechanism of action of gibberellic acid in the reversal of virus-caused stunting.

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References and Notes

1. P. W. Brian and H. G. Henning, *Physiol. Plantarum* 8, 669 (1955); B. O. Phinney, *Proc. Natl. Acad. Sci. U.S.* 42, 185 (1956).
2. L. V. Barton, *Contrib. Boyce Thompson Inst.* 18, 311 (1956).
3. K. Maramorosch, *Plant Disease Reptr.* 39, 896 (1955).
4. The gibberellic acid was kindly supplied by Curt Leben, Agricultural Research Center, Eli Lilly & Co., Greenfield, Ind.

17 July 1957

Weber's Law and the Difference Threshold for the Velocity of a Seen Object

Although a fairly extensive literature exists concerning the visual perception of stimulus movement (*1*), only one experiment has been reported (*2*) which deals directly with the measurement of difference thresholds for the velocity of a seen object. According to that report: "An approximate correspondence with Weber's Law was found, the divergence from it appearing, in general, as an increase of the threshold at both ends of the range of initial velocities. The Mean Threshold (0.5 probability of perception, corrected for guessing) was, in favourable conditions, about 12 per cent of the initial velocity. Whether the stimulus was an increase or a decrease of velocity made no marked difference."

It is found, however, that when Hick's data are plotted (Fig. 1, broken curve), the resulting function may be interpreted as passing through an optimal $\Delta V/V$ value, rather than being a generally straight line of zero slope, which approximate correspondence with Weber's law would require. Because of this interesting alternative interpretation, a partial replication of Hick's experiment was undertaken.

Hick obtained thresholds for instantaneous increments and decrements in velocity for a pip horizontally deflected across the face of a cathode-ray tube. The total excursion of the pip seems to have been about 3.5 in., the velocity increment (or decrement) being introduced at the mid-point. For the replication, the total excursion of the pip (in inches) and the initial velocities of the pip (in inches per second) closely matched Hick's values (*2*). However, since it proved convenient to use a scope hood giving a viewing distance of 10 in., the viewing distance was approximately one-half of the 21-in. distance used by Hick. The chief consequences of this difference in viewing distance were the yield of a range of initial velocities higher than those of Hick when velocity is measured in terms of visual angle per second and the doubling, approximately, of the total angular excursion of the pip. Since Hick found no marked difference between incremental and decremental thresholds, it was decided to restrict this replication to incremental velocities only.

The remaining curves of Fig. 1 compare the incremental data obtained in the present experiment with those of Hick. In the new data, each point is based on 300 values—30 judgments for each of ten subjects; similar information is not reported in the earlier work. The thresholds in the present study were determined by average *z*-score computations (*3*); other methods were tried and yielded similar over-all functions.

In general, the findings of the two experiments agree fairly well, showing that as initial velocity increases, $\Delta V/V$ at first decreases and then increases. Of interest is the fact that when the upper limit of initial velocities is extended, as in the present experiment, it becomes evident that if Weber's law holds at all, it does so for a very small portion of the usable range only. It may, indeed, be safe to conclude that the Weber fraction passes through a minimum in the 1-to-3-degrees-per-second region of the range of initial velocities.

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References

1. C. H. Graham, in *Handbook of Experimental Psychology*, S. S. Stevens, Ed. (Wiley, New York, 1951).
2. W. E. Hick, *Quart. J. Exptl. Psychol.* 2, 33 (1950).
3. R. S. Woodworth and H. Schlosberg, *Experimental Psychology* (Holt, New York, 1954).

10 July 1957

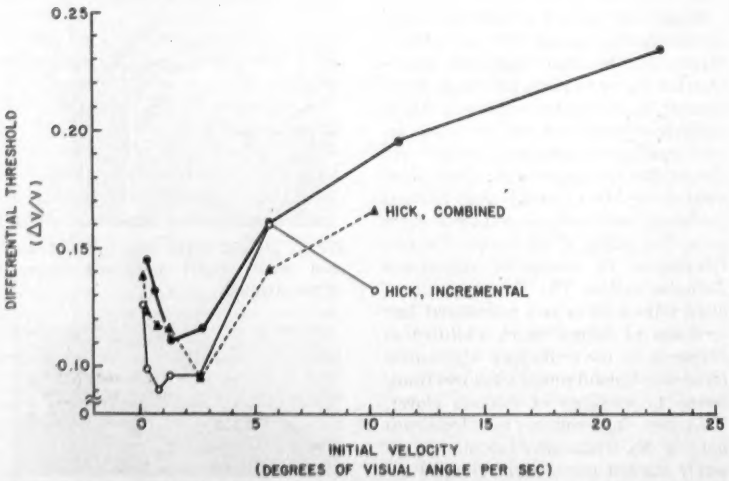

Fig. 1. Difference thresholds for the velocity of a seen object as a function of initial velocity. The uppermost curve is for data gathered in the study here reported; the other curves were plotted from tables presented by Hick (*2*).

Evidence for an Accessory Pathway of Galactose Metabolism in Mammalian Liver

Recent studies on the disease galactosemia have revealed it to be the result of the congenital deficiency of a specific enzyme important in the conversion of ingested galactose to glucose derivatives (*1*). Normally, ingested galactose is first converted by means of adenosine triphosphate and galactokinase to α-galactose-1-phosphate (Gal-1-P), which can then be transformed to α-glucose-1-phosphate (G-1-P) through a series of reactions involving uridine diphosphate glucose (UDPG) and uridine diphosphate galactose (UDPGal). Thus (*2*):

$$\text{Gal*-1-P} + \text{UDPG} \underset{\text{P-Gal transferase}}{\rightleftharpoons} \text{UDPGal*} + \text{G-1-P} \quad (1)$$

$$\text{UDPGal*} \underset{\text{UDPGal-4-epimerase}}{\rightleftharpoons} \text{UDPG*} \quad (2)$$

$$\text{UDPG*} + \text{PP} \underset{\text{UDPG pyrophosphorylase}}{\rightleftharpoons} \text{UTP} + \text{G*-1-P} \quad (3)$$

The asterisk traces the galactose moiety through its conversion to glucose-1-phosphate. In galactosemia, the enzyme catalyzing reaction 1 (P-Gal transferase) is

Table 1. Incorporation of C^{14}-labeled α-galactose-1-phosphate into uridine nucleotide by partially purified (16-fold) rat liver enzyme.

Incubation	Amount incorporated (count/min)
Complete system	9,770
Minus uridine triphosphate	550
Plus pyrophosphate (5 μmole)	2,850
Plus pyrophosphatase	11,100
Heated enzyme	470

missing and results in the accumulation of galactose-1-phosphate. However, in spite of this demonstrated enzymatic defect, there are several indications that some metabolism of galactose is possible and does, in fact, occur in this condition. Thus, on clinical grounds it has been observed repeatedly that, as patients with galactosemia increase in age, they appear to develop an increased ability to utilize ingested galactose (*3*). More recently, studies on a 24-year-old male with galactosemia have demonstrated that the infusion of galactose-1-C^{14} (together with oral menthol) resulted in labeling of the isolated urinary menthol glucuronosidic acid (*4*). From our knowledge of the role of the uridine nucleotides in glucuronosidic acid formation (*5*), it appeared that, in spite of the seemingly complete P-Gal transferase block, the ingested galactose was probably converted to uridine diphosphate galactose prior to the appearance of the label in the glucuronisidic acid.

These clinical and laboratory findings suggested that there might exist an additional pathway for the conversion of galactose-1-phosphate to uridine diphosphate galactose other than that catalyzed by P-Gal transferase. It seemed reasonable to assume that uridine diphosphate galactose synthesis might occur by way of a pyrophosphorolytic reaction (analogous to reaction 3) as follows:

$$\text{Gal-1-P} + \text{UTP} \underset{\text{UDPGal pyrophosphorylase}}{\rightleftharpoons} \text{UDPGal} + \text{PP} \quad (4)$$

The existence of such a reaction in yeast had originally been suggested by Kalckar *et al.* (*6*), and more recently an enzyme catalyzing such a pyrophosphorolysis has been observed in plants (*7*).

We have now obtained evidence for the existence of such an enzyme system in mammalian liver. Rat, pigeon, and human liver were examined and found to contain enzymatic activity. The enzyme is called uridine diphosphate galactose pyrophosphorylase, in conformity with previous nomenclature. The enzyme system was initially detected and studied by demonstrating the formation of labeled uridine diphosphate galactose from the incubation of uridine triphosphate (UTP) with 1-C^{14}-labeled galactose-1-phosphate and various cell-free liver fractions. The 1-C^{14}-labeled galactose-1-phosphate was prepared enzymatically from 1-C^{14}-galactose, adenosine triphosphate, and yeast galactokinase (*8*). The uridine diphosphate galactose formed as a result of the enzymatic reaction was identified by paper chromatography and autoradiography. It was found to migrate as a uridine diphosphate hexose in the neutral ammonium acetate-ethanol system of Leloir (*9*), and hydrolysis of this uridine nucleotide in 0.02*N* H_2SO_4 yielded a sugar which was identified as galactose in two chromatographic systems [pyridine-ethyl acetate-water; and water-saturated phenol (*10*)].

By means of differential centrifugation (*11*), the uridine disphosphate galactose pyrophosphorylase activity has been found to be located in both the nuclear and cytoplasmic (soluble) compartments of the liver cell. From the latter fraction as well as from extracts of liver acetone powder, the enzyme has now been purified more than 16-fold and shown to be free of nucleotides, glucose-1-phosphate, and glycogen.

In Table 1 are depicted results from an experiment using this partially purified enzyme. The complete system included the enzyme (1.2 mg of protein), 0.1 μmole of 1-C^{14}-galactose-1-phosphate (specific activity 500,000 count/min μm), 2 μmole of uridine triphosphate, 5 μmole of $MgCl_2$, and 20 μmole of 0.2*M* tris (hydroxymethyl) aminomethane at *p*H 7.4 in a total volume of 0.6 ml. After incubation for 30 minutes at 38°C, the mixture was deproteinized with 5-percent trichloroacetic acid. The nucleotides were then adsorbed and eluted from norite, as has been previously described (*12*). The radioactivity in the norite eluates shown in Table 1 represents the incorporation of 1-C^{14}-galactose-1-phosphate into uridine nucleotide. It will be noted that significant incorporation of counts occurred only in the complete system and that pyrophosphate inhibited, while inorganic pyrophosphatase stimulated, incorporation of the label. The reversibility of the reaction has also been confirmed by studies with C-14-uridine diphosphate galactose.

The findings presented indicate the existence in mammalian tissues of the enzyme uridine diphosphate galactose pyrophosphorylase, which provides an alternate route for both the utilization of galactose-1-phosphate and the synthesis of uridine diphosphate galactose. The enzyme has thus far been found in significant amounts only in the liver, where its activity is about one-sixth of that of P-Gal transferase (per gram of liver).

Table 2. Activity of uridyl transferase and pyrophosphorylase enzymes in rat liver with respect to age of animal. (Results are average of three sets of experiments and are expressed as millimicromoles of reactants converted per milligram of liver protein, per 20 min).

	P-Gal transferase*	UDPG pyrophosphorylase*	UDPGal pyrophosphorylase
Fetal†	6.8	340	0.9
Neonatal (1 day)	7.7	348	1.6
Adult (60 days)	39.4	98	7.6

* Determined by methods cited in (*1*). † The animals were sacrificed on 18th day of gestation; normal gestation, 21 days.

Additional studies on the enzymatic activity of the liver with respect to age are shown in Table 2. It will be observed that P-Gal transferase and uridine diphosphate galactose pyrophosphorylase activities are strikingly lower in fetal and neonatal rat liver than in the adult organ, while the reverse is true for the uridine diphosphate glucose pyrophosphorylase activity. In preliminary studies on human liver, similar enzyme differences with age have been found.

It is thus tempting to speculate that patients with galactosemia develop their most pronounced symptoms in infancy, because at this time they have both a pathological absence of P-Gal transferase and a physiologically feeble uridine diphosphate galactose pyrophosphorylase. The subsequent increase in activity of the latter enzyme with age might then effectively explain the improved galactose metabolism which occurs in these patients despite the continued lack of P-Gal transferase (*13*).

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References and Notes

1. H. M. Kalckar, E. P. Anderson, K. J. Isselbacher, *Biochim. et Biophys. Acta* 20, 262 (1956); K. J. Isselbacher *et al.*, *Science* 123, 635 (1956).
2. Abbreviations: UTP, uridine triphosphate; G-1-P, α-glucose-1-phosphate; Gal-1-P, α-galactose-1-phosphate; PP, pyrophosphate; UDPG, uridine diphosphate glucose; UDPGal, uridine diphosphate galactose; UTP, uridine triphosphate.
3. E. H. Townsend, Jr., H. H. Mason, R. S. Strong, *Pediatrics* 7, 760 (1951).
4. F. Eisenberg, Jr., K. J. Isselbacher, H. M. Kalckar, *Science* 125, 116 (1957).
5. G. J. Dutton and I. D. E. Storey, *Biochem. J. (London)* 57, 275 (1954); J. L. Strominger *et al.*, *J. Am. Chem. Soc.* 76, 641 (1954).
6. H. M. Kalckar, B. Braganca, A. Munch-Petersen, *Nature* 172, 1038 (1953).
7. E. F. Neufeld *et al.*, *Arch. Biochem. and Biophys.* 68, 602 (1957).
8. L. F. Leloir and R. E. Trucco, in *Methods in Enzymology*, S. P. Colowick and N. O. Kaplan, Eds. (Academic Press, New York, 1955), vol. 1.

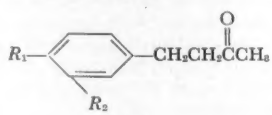
9. A. Paladini and L. F. Leloir, *Biochem. J. (London)* 51, 426 (1952).
10. M. A. Jerwyn and F. A. Isherwood, *ibid.* 44, 402 (1949); E. F. Wellington, *Biochim. et Biophys. Acta* 7, 238 (1951).
11. W. C. Schneider and G. H. Hogeboom, *J. Biol. Chem.* 183, 123 (1950).
12. E. P. Anderson, H. M. Kalckar, K. J. Isselbacher, *Science* 125, 113 (1957).
13. These studies were supported in part by a grant (A-1392) from the National Institutes of Health.

9 August 1957

Anisylacetone, Synthetic Attractant for Male Melon Fly

Attractants have recently received increasing attention as an effective means for combating insect pests. By baiting traps with specific attractants, it is possible to discover an insect infestation at an early stage, and control measures may then be initiated immediately. Attractants in traps are also of use in delineating the areas that must be treated and in following the progress of the control program. Certain attractants in combination with a suitable insecticide may also be used to lure insects to their death.

The Agricultural Research Service has been conducting investigations on attractants for fruit flies at its Honolulu and Mexico City laboratories for many years (*1–3*). Since November 1955 chemists at Beltsville have been synthesizing and supplying candidate chemicals for testing in these laboratories. Recently, as a result of these studies, it was found that anisylacetone (formula Ib) is an effective attractant for the male melon fly (*Dacus cucurbitae* Coq.) (*4*).

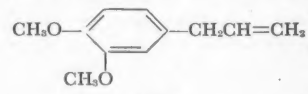


(I)

$R_1 = R_2 = H$ (Ia)
$R_1 = CH_3O$; $R_2 = H$ (anisylacetone) (Ib)
$R_1 = R_2 = CH_3O$ (Ic)

After more than 1000 compounds had been screened in Hawaii, it was found that the male melon fly was attracted by a number of aromatic ketones. Benzylacetone (formula Ia) and anisylacetone [formula Ib, 4-(*p*-methoxyphenyl)-2-butanone)] were the most attractive compounds, but field tests indicated that the latter was superior. These pleasant-smelling compounds are prepared by condensing an aromatic aldehyde such as anisaldehyde with acetone and hydrogenating the product. Anisylacetone has been described by Sosa (*5*), and by Chen and Barthel (*6*), who used it as an intermediate in the preparation of pyrethrinlike esters.

Analogous compounds are not as attractive as anisylacetone. Introduction of another methoxyl on the benzene ring gives a compound (formula Ic) which is no longer attractive to the melon fly but which is rather attractive to the oriental fruit fly (*Dacus dorsalis* Hendel). The similarity of this compound to the outstanding attractant for the oriental fruit fly, methyl eugenol (formula II) (*2*), is apparent.



(II)

The discovery and practical evaluation of the attractiveness of anisylacetone were timely. The compound was put to use almost immediately in California to determine the extent of a possible melon fly infestation. With the help of the attractant, the state and federal officials promptly undertook an extensive trapping program, and it became apparent that the single melon fly found was an isolated specimen of unknown origin.

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References and Notes

1. Agricultural Research Service, *U.S. Dept. Agr. PA 301* (1956); M. McPhail, *J. Econ. Entomol.* 32, 758 (1939).
2. L. F. Steiner, *J. Econ. Entomol.* 45, 241 (1952).
3. P. L. Gow, *ibid.* 47, 153 (1954); L. F. Steiner, D. H. Miyashita, L. D. Christenson, *ibid.*, in press; A. C. Baker *et al.*, *U.S. Dept. Agr. Misc. Publ. 531* (1944).
4. The encouragement and support of S. A. Hall at the Beltsville laboratory and of L. D. Christenson and Doris H. Miyashita at the Honolulu station is gratefully acknowledged.
5. A. Sosa, *Ann. chim.* 14, 5 (1940).
6. Y.-L. Chen and W. F. Barthel, *J. Am. Chem. Soc.* 75, 4287 (1953).

8 July 1957

Diurnal Cycles and Learning in Earthworms

Recent studies of learning in earthworms (*1*) are important, not only for the data accumulated relative to a science of comparative psychology, but also because they appear to have relevance to a general theory of behavior. Because of these considerations, as well as the general lack of basic behavioral studies concerned with this species, an attempt was made (*2*) to follow up an incidental observation of a previous study (*3*) which had indicated that the diurnal cycle of the earthworm plays a significant role in the rate at which this organism acquires a particular turning tendency in a T-maze.

An early study by Baldwin (*4*), in which observations were made of *Lumbricus terrestris* placed in dirt between two parallel glass plates ⅜ in. apart, revealed that, in terms of crawling movements, feeding, and ejection of waste products, earthworms have definite activity cycles, with the active period occurring between 6 P.M. and 12 P.M. The present report attempts to extend these observations through study of the effect on learning of the earthworm activity cycle.

The apparatus used in this study was a T-maze constructed by fastening pieces of Lucite to a sheet of plywood. The stem and crosspiece of the maze were each 25.4 cm long, 2 cm wide, and 2 cm high; a Lucite cover was hinged in such a manner that each third of the runway could be opened independently. The left arm (negative goal) was 10.1 cm long and contained a 1-cm piece of 2/0 sandpaper 8 cm from the choice-point, followed immediately by two copper bell wires 0.25 in. apart, through which a shock of 1 v could be administered. The right arm (positive goal) was 15.3 cm long and ended in a beaker containing moist earth and moss, which was wrapped in paper in order to provide a dark interior.

One group of six earthworms (*L. terrestris*) was given five trials per day between 8 P.M. and midnight, with the negative and positive reinforcement, until a criterion of seven consecutive correct trials was achieved. The same procedure was utilized with a second group of six earthworms, except that the training was carried out between 8 A.M. and noon. A trial was considered correct if the worm entered the beaker without being shocked. Between trials on successive days, the worms were kept in a refrigerator. It should be noted that the conditions of the experimental room yielded no differential day-night cues to the two groups of worms.

Stimulation was applied by a camel's-hair paint brush if the worm remained motionless in the maze for 30 seconds. If, after 5 seconds of stimulation with the brush, the worm continued to remain motionless, a flashlight was turned on and held vertically slightly behind the anterior end of the worm. In all cases the worm began to move when the light was applied.

The mean number of trials to reach the criterion in the evening group was 32 (standard deviation, 4.01); the mean number of trials in the morning group was 45 (standard deviation, 5.27). A *t*-test shows that the evening group achieved the learning criterion in significantly ($p < 0.01$) fewer trials than did the group run in the morning hours. The

use of the Mann-Whitney *U*-test, a nonparametric alternative to the *t*-test (*5*), confirms the significance of the difference in learning in the two groups. Analysis of brush and flashlight applications reveals that the evening group required significantly ($p < 0.05$) less stimulation per trial than did the morning group. Stimulation-per-trial measures were used because of the significant differences in the total number of trials that the two groups were run.

Since the morning group was run by one experimenter (J.P.M., *2*) and the evening group by me, an additional four animals were run in the evening by J.P.M. to insure that the procedure for running and stimulating animals was the same for both experimenters. No differences were noted between these four worms and the six others run in the evening group on any of the measures.

No specific control over temperature cues was exercised in this study; a record was kept, however, of the temperature of the room at the time of the first trial on each day for each worm. On the basis of the mean temperature for each worm, the 12 subjects were divided into a high-temperature group of six and a low-temperature group of six. No significant difference in the number of trials necessary to achieve the learning criterion was found between these two groups. Although this does not completely preclude the possibility that temperature may be an important variable (since there may have been temperature fluctuations during the five trials on any one day)—in particular, a temperature effect interacting with the time parameter—the experimental conditions of the present study did not lend themselves to greater control.

It may be concluded that the diurnal cycle plays an important role in maze learning in earthworms. This cycle appears to carry over to a learning situation where light-dark cues are eliminated from the environment. Wells (*6*) has noted the existence of diurnal activity cycles in the lugworm which continue for several days after the animal is placed in an environment free of diurnal cues, while other investigators report this persistence of cyclical activity in other species (*7*). It is possible that, like the feeding and irrigation cycles of the lugworm, the earthworm diurnal cycle is controlled by an "internal pacemaker."

At present there is relatively little evidence concerning the neurological structures which may act as pacemakers in regulating the biological activity of the worm. Scharrer and Scharrer (*8*) have noted the existence of neurosecretory cells in the brain of the earthworm; the function of these cells is as yet undetermined. Ziller-Perez (*9*) has indicated that the chromaffin cells in certain species of worms secrete an adrenalinlike substance. A tentative hypothesis might attribute the cyclical activity of the earthworm to the products of these cells. This hypothesis, however, sheds no light on the basic problem of the manner in which the cyclical pattern is imposed on the functioning of these cells.

Just as Schmidt (*1*) has shown that one cannot generalize from the avoidance behavior of one species of worm (*L. terrestris*) to the avoidance behavior of another species (*Eisenia foetida*, a manure worm), this study shows that time of learning relative to the worms' activity cycle is an important variable in research with Annelida.

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References and Notes

1. J. S. Robinson, *J. Comp. Physiol. Psychol.* 46, 262 (1953); H. Schmidt, Jr., *Science* 121, 341 (1955); R. P. Bharucha-Reid, *ibid.* 123, 222 (1956).
2. I would like to express my appreciation to James P. McLean, Monterey, Calif., for his assistance in these studies.
3. J. Arbit, unpublished manuscript.
4. F. M. Baldwin, *J. Animal Behavior* 7, 187 (1917).
5. S. Siegel, *Nonparametric Statistics for the Behavioral Sciences* (McGraw-Hill, New York, 1956).
6. G. P. Wells, in *Symposia of the Society for Experimental Biology* No. IV, *Physiological mechanisms in animal behavior* (Cambridge Univ. Press, Cambridge, England, 1950).
7. F. A. Brown, Jr., *et al.*, *J. Exptl. Zool.* 123, 29 (1953); *Sci. American* 190, 34 (1954).
8. E. Scharrer and B. Scharrer, *Physiol. Revs.* 25, 171 (1945).
9. H. V. Ziller-Perez, *J. Comp. Neurol.* 78, 367 (1942).

* Presently on active duty with the U.S. Army.

1 August 1957

Extension of a Tracheole into Cytoplasm

In the course of an electron microscope study of spermatogenesis in the grasshopper (*Melanoplus differentialis*), a cell of the testicular theca was observed which is penetrated by a tracheole (*1*). The electron micrograph (Fig. 1) is presented because it illuminates two points: the structural details of the terminal portion of the tracheole and its position in relation to the cell.

The tracheole, which seemingly penetrates the cytoplasm of the thecal cell, clearly has taenidia (*TN*). This confirms the findings of Keister (*2*), Richards and Korda (*3*), and Beams and Anderson (*4*) that all respiratory tubes of the insect species examined possess taenidia. Furthermore, the taenidia are accompanied by cytoplasm. Buck (*5*), Keister (*2*), and Beams and Anderson (*4*) have observed tracheoles that emerge from their originating cells accompanied by protoplasmic processes. At the junc-

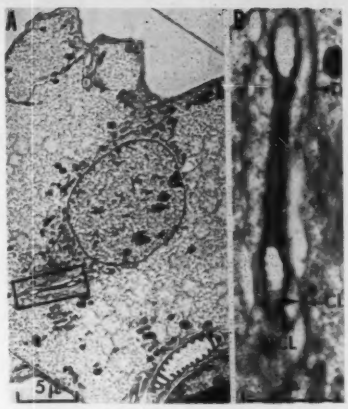

Fig. 1. (*A*) Thecal cell from grasshopper testis, penetrated by a tracheole (× 1850). (*B*) Enlargement of the tracheole-entered area revealing taenidia (*TN*), thecal cell membrane or limit (*CL*), and tracheolar cytoplasmic limit (*TCL*). At various regions (for example, *D*) each limit appears to be composed of a double membrane (× 15,000).

tion of the cytoplasm of the thecal cell and that of the tracheole is a double membrane, of which one part (*CL*) appears to be a limit of the cell cytoplasm and the other (*TCL*), the limit of the cytoplasm associated with the tracheole. At the region *D* each membrane appears to be double.

In this species, the terminal portion of the tracheole has an intima with recognizable taenidia, whose lumen measures 0.30 μ in diameter. In addition, beyond the limits of the taenidial border, this tracheole is surrounded by cytoplasm and has its own limiting membrane. The over-all diameter of the tracheole is about 0.67 μ. There is also evidence here that the tracheole does not end on the peripheral surface of the thecal cell but extends into the interior. However, the presence of the double membranes suggests that the tracheole has assumed its position, not by actual intracellular penetration, but by causing or following an invagination of the thecal cell membrane to the inner portion of the cell.

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References and Notes

1. This work was performed under the auspices of the U.S. Atomic Energy Commission.
2. M. L. Keister, *J. Morphol.* 83, 373 (1948).
3. A. G. Richards and F. H. Korda, *Ann. Entomol. Soc. Amer.* 43, 49 (1950).
4. H. W. Beams and E. Anderson, *Biol. Bull.* 109, 375 (1955).
5. J. B. Buck, *Ann. N.Y. Acad. Sci.* 49, 397 (1948).

5 August 1957

Book Reviews

Gas Chromatography. A. I. M. Keulemans. Reinhold, New York, 1957. xix + 217 pp. Illus. $7.50.

In the last few years, the technique of gas chromatography—that is, the chromatography of volatile substances in which a permanent gas is used as the moving phase—has grown very rapidly. It is becoming standard in many laboratories, both industrial and academic, as a means of analysis of volatile mixtures. Of late, several manufacturers of scientific apparatus have produced gas chromatography machines that join the ranks of the magic black boxes which form the physical analyst's stock-in-trade.

In view of the rapid rate of growth of the subject at present, A. I. M. Keulemans' book should be very valuable. After an initial chapter in which gas chromatography is compared with similar analytic methods, there is a chapter outlining the apparatus used in its technique and the way in which it will perform both qualitative and quantitative analysis. Several examples from the published literature are quoted, displaying practical analyses. In the third chapter, the components of the apparatus are described in greater detail. These three chapters give the basic outline of the subject. The book then continues in greater detail, presenting a theory of the chromatographic process, which is developed into a discussion of the design, construction, and performance of gas-chromatographic columns. The discussion is extensively illustrated from practice and gives much information which makes it possible to use the technique in the most effective manner.

The book is a textbook rather than a comprehensive treatise. The material discussed has been selected with regard to its importance and is particularly valuable to those who use commercial instruments. Nine-tenths of the book is devoted to the gas-liquid partition chromatography of Martin and James, while there is only a short section on gas-solid adsorption chromatography, which is at present rather overshadowed by the other. The treatment of the theory of the column and its operation is much more detailed than the description of the apparatus. This is inevitable, since the design of the apparatus is so diverse and is developing so rapidly, whereas the theory will, it is presumed, remain invariable.

Keulemans is associated with the Shell Oil Company, whose work in this field is outstanding. He has drawn extensively on Shell work, and in places where views might be controversial, he voices those of Shell workers. The accent throughout is on the use of the technique in the oil industry. Certainly, to date, the method has been of the greatest value in this industry, and the oil companies have done the greater part of the development. However, it should be emphasized that the technique is of general application to anything volatile, and this book should be of great interest to anyone who feels that he should know about the analysis of any volatile mixture.

A. B. LITTLEWOOD
Newcastle upon Tyne, England

The Calculation of Atomic Structures. Based on lectures given under the auspices of the William Pyle Fund of Haverford College, 1955. Douglas R. Hartree. Wiley, New York; Chapman & Hall, London, 1957. 181 pp. Illus. $5.

This book has been written in response to a recent revival of interest in the results of calculations of atomic structures and of methods of carrying out such calculations. This interest has been quickened by the rapid development of automatic digital computing machines and methods, which will make atomic structure calculations easily practicable on a much more generous scale than before and over a much greater range of cases (notably, for heavier atoms). The book "is intended for those who want to know about, or to carry out, quantitative calculations of atomic structure" to the degree of approximation embodied in wave functions of the "self-consistent field" type, using the methods developed by Hartree and Fock. The book makes no attempt to deal with the more detailed features of atomic energy states, such as multiplet structure, hyperfine structure, or the effects of external fields.

The first three chapters comprise a brief introduction, a discussion of the application of the variation principle to atomic structure, and the derivation of basic equations for the computation of atomic wave functions and energies in the self-consistent field approximation for closed-shell atomic states ("configurations of complete groups").

Chapters 4 and 5 describe, in considerable detail, numerical procedures for the solution of the self-consistent field problem in the closed-shell case, and their application. The book as a whole, and these how-to-do-it chapters in particular, for the first time bring together in one convenient place the fruits of the author's long experience in hand computations with the self-consistent field method. All the most recent improvements in technique through 1956 are included. Chapter 6 extends the discussion of chapters 3 through 5 to configurations comprising incomplete groups. The possibility that modified techniques or approaches may be more suitable in digital computer programming is considered very briefly, but actual methods of implementation of machine computations, already under way in two or three places, are not discussed.

Chapter 7 is designed to fill the need for the best possible procedures for interpolation between cases of atoms or ions for which self-consistent field calculations have been made. (For example, if self-consistent field wave functions were known for Si and S but not for P, one might estimate those for the latter by interpolation.) At the present time, such interpolation procedures are needed because not much more than a sampling of all cases of interest has been carried out, except for the lightest atoms. They are needed for either or both of two reasons: (i) for the calculation of atomic properties, in lieu of wave functions computed directly by the self-consistent field method; (ii) for use as initial estimates in making self-consistent field calculation, since the effort of making such a calculation can thereby be greatly reduced. Various useful curves, diagrams, and (in Appendix 2) tables are included.

Chapter 8 sets forth methods for computing the energies, in particular of levels differing in the number or state of excitation of outer electrons, when self-consistent field wave functions are known. Chapter 9 briefly surveys how the self-consistent field calculations may be extended to take account of relativistic effects.

Chapter 10 is an up-to-date critical brief review of methods of obtaining better approximations to atomic wave

functions than are afforded by the self-consistent field method. The familiar "two kinds of improvement" to give needed electron correlation—namely, by configuration mixing and by explicit use of the interelectronic distance as a variable—are considered; after this there is a small section on polarization.

Appendix 3, added in October 1956, comprises notes and references to bring the earlier material up to date. Although the book itself deals with self-consistent field methods and not with results, Appendix 1 gives access, through a reference list, to all self-consistent field results published up to late 1956.

Douglas Hartree's small book will be a valuable reference source for those wishing to make self-consistent field calculations and will also be useful in its up-to-date references to self-consistent field theory and results and to related matters.

ROBERT S. MULLIKEN
University of Chicago

Mammals of the Great Lakes Region. W. H. Burt. University of Michigan Press, Ann Arbor, 1957. 248 pp. Illus. $4.75.

Mammals of the Great Lakes Region is a revision of the author's *Mammals of Michigan*. It includes the natural area of the Great Lakes drainage. Since plants and animals are no respecters of political boundaries, W. H. Burt has wisely chosen a natural area that takes in the watershed of these five lakes. Parts of eight states and Ontario are included. Wild mammals are difficult to study. For the most part, the smaller species are secretive and nocturnal; the larger forms, too, are difficult to observe. The author has introduced the known facts in a succinct manner, including not only his own great knowledge of mammals but that of others in the field.

Presenting some principles of adaptations, home range, populations, and so forth, Burt treats the 78 species and three recently extinct forms in admirable style. A short description, habits, and the known geographic range are documented for each species. Stylized sketches by the author help to identify the genus.

For each species there is a distribution map, which gives the present known range of the species within the area discussed. Unlike the ornithologist, the student of mammals must trap continuously to secure data on distribution and life-history of the smaller mammals. Too often it is a frustrating chore.

A summarized table includes data on the tooth formula, measurements and weights, gestation, number of young and litters, longevity, and home range. Selected references, both general and specific, provide a source for the reader who may wish to pursue the subject further. The book will serve the amateur and professional naturalist alike.

W. J. HAMILTON, JR.
Cornell University

Notions de Cytologie et Histologie. M. Chèvremont. Desoer, Liége, 1956. iv + 994 pp. Illus. + plates.

This impressive volume differs from other textbooks of histology mainly in its first section, on the cell, which, together with an introduction on history, methods, and techniques, covers 286 of the 994 pages. In this section the structure, cytochemistry, and biological significance of the cell and its constituents are unusually well and thoroughly presented. Concentrating on the cells in higher vertebrates, Chèvremont nevertheless succeeded in unfolding the entire aspect of present-day cytology, thereby producing not only an excellent introduction for students but also a highly informative and stimulating treatise for the workers in the field. To give a randomly chosen example, one finds not only a report on the antimitotic substances and their particular effects but also a discussion of their significance for the analysis of mitosis. Another example to indicate the broad and well-balanced presentation is the consideration of the profound physical changes that occur in the cytoplasm during mitosis, in spite of the greater stress present cytology must place on the chemical and metabolic changes. A third example is a brief and well-designed chapter devoted to the part that cytoplasmic constituents may play in heredity.

Although the second section, on the tissues, is traditional in the descriptions of epithelia (including glands and secretion in general) and connective tissue and its derivatives (including blood and muscle) and nervous tissues, it is consistent with one of the main tendencies of the book in that it states the problems of histology against the background of biology. This is emphasized by an introductory chapter on cell differentiation and specificity, which deals with the relationship of histology to embryology, to experimental biology, and to tissue culture. One may wonder here why growth and morphogenesis were not also considered. For each tissue the data on histogenesis, histophysiology, and histochemistry are presented.

The third section, on cell systems, apparatus, and organs, is in no way deprived of its fair share of attention by the elaborate presentations of the cell and the tissues. Except for the chapters on the nervous system and the sense organs, which give the impression of being appendixes rather than full-grown parts of the whole, there is adequate information on microscopic anatomy. The broad biological and functional approach was maintained throughout the special parts; a chapter such as that on the "Système histiocytaire" (18 pages), preceding the description of blood-forming organs, is especially characteristic of Chèvremont's high standard of teaching. Embryology, innervation, and blood supply are discussed for each organ, and separate sections on histophysiology (which cover four and a half pages for the lung, five and a half pages for the kidney, and four pages for the liver) emphasize the functional significance of the microscopic structures.

The volume is well and amply illustrated with about 300 microphotographs, several electron micrographs and diagrams, and ten plates of about 30 colored pictures. A subject index of 30 pages facilitates the use of the book and shows the wealth of information it has to offer.

Numerous references at the end of paragraphs, in footnotes, and in the text keep the reader up to date on the literature and serve to stimulate discussions and develop controversial points instead of presenting them in definite form. Early sources of our knowledge are referred to in the reviews on the history of a particular line of research. Since Giuseppe Levi's *Trattato Istologico* is the great European standard work, where additional information can be found, it seems unfortunate that the third edition (1946) is listed instead of the fourth (1954).

The volume is written in simple, lucid, and precise language, and it should be easily read even by those with a limited knowledge of French.

F. WASSERMANN
Argonne National Laboratory

A Manual of Pharmacology and Its Applications to Therapeutics and Toxicology. Torald Sollmann. Saunders, Philadelphia, Pa., ed. 8, 1957. 1535 pp. $20.

Just 40 years ago, the first edition of Sollmann was published and immediately became the major American textbook in pharmacology. Seven new editions have now followed the first. During these years, at least two other comprehensive textbooks have appeared —Goodman and Gilman, now in its second edition, and the recent composite volume edited by Drill—and other only slightly shorter volumes, like that of Krantz and Carr. These illustrate the in-

creasing growth of the field and the need for different books for different audiences. One might compare some of the strong points of these books (although admittedly the points are shared by all) by saying that Goodman and Gilman is particularly welcomed by medical students, Drill, by practitioners, and Sollmann, by serious workers in pharmacology, for it is an unequaled source of clear fact and detail. One turns to it automatically when specific information is needed. Although one hesitates to use the word *encyclopedic* because it sometimes suggests to students a forbidding tome, Sollmann is encyclopedic in the good sense and, at the same time, attractive to beginning workers. The device of large type and small type has always helped in this respect. All in all, this eighth edition is a worthy successor to the now almost legendary series of earlier volumes. The general content is the same—a systematic coverage of the field of pharmacology—and hardly needs further description.

It is impossible to close this review without a word about Torald Sollmann, the man. With Sollmann, the old quotation that "no man is the equal of his book" hardly applies, for he is truly the elder statesman of American pharmacologists, the very active chairman of the Council on Drugs of the American Medical Association, and the possessor of a legion of devoted friends.

WINDSOR CUTTING
Stanford Medical School

Progress in Low Temperature Physics. vol. 2. C. J. Gorter, Ed. North-Holland, Amsterdam; Interscience, New York, 1957. xi + 480 pp. Illus. $10.75.

This is the second, and last, volume of what amounts to a handbook of low-temperature physics. This volume consists of 14 separate articles, grouped in chapters, written by 22 people all of whom are specialists well known to the majority of workers in this field. The accounts are, accordingly, authoritative throughout and cover a considerable diversity of topics.

Authors of review articles (which these chapters are, essentially) are forced to be selective in their choice of material, especially in a swiftly developing and many-sided subject. Their choices are not always, and in fact not often, entirely pleasing to their colleagues. This is very likely to be the case with this book. Thus, some chapters appeared excellent to me, while others (I thought) might well have been deleted.

Specifically, the article by K. R. Atkins on the problems of the mobile helium film is first-rate and a pleasure to read, and it ought to be useful to everybody interested in this rather bizarre phenomenon. The same is true of the article on a very different topic—semiconductors at low temperatures—by V. A. Johnson and K. Lark-Horovitz. This article contains a great deal of information that is very difficult to dig out of the extensive literature. The chapter by D. Shoenberg on the "de Haas–van Alphen" effect contains all the latest thinking on that subject and is excellently presented.

To illustrate the diversity of the work, there is a very good chapter by M. J. Steenland and H. A. Tolhoek on nuclear spin alignment, especially of radioactive nuclei, by means of magnetic cooling techniques. This is a fairly recent and interesting development, since it amalgamates two hitherto unconnected fields of physics—namely, cryogenics and nuclear physics. The book was published before the use of this method to test parity conservation was reported, but the basic ideas are here outlined.

The book includes many other topics, such as theories of liquid helium (J. de Boer), paramagnetic relaxation (C. J. Gorter), solid helium (C. Domb and E. S. Dugdale), transport phenomena in metals at low temperatures (E. H. Sondheimer), liquid helium below 1°K (H. C. Kramers), and half a dozen other topics. It closes with an expert discussion by H. Van Dijk and M. Durieux of the "temperature scale." In principle, the precise determination of the Kelvin temperature of a batch of liquid helium is one of the nastiest measurements imaginable. In practice, it could be carried out easily by any reasonably bright sophomore. This happy paradox is the result of the patient and skilled work which has been going on for many years, mainly at Leiden, relating the Kelvin scale to the saturated vapor pressure. A very usable p versus T table, embodying the latest results, is included, and the whole is condensed to one page, which makes it very handy for photographic reproduction.

The printing leaves something to be desired. In my copy eight pages were blank, and the caption for one figure was several pages farther along.

C. T. LANE
Yale University

Pilot Plants, Models, and Scale-up Methods in Chemical Engineering. Robert E. Johnstone and Meredith W. Thring. McGraw-Hill, New York, 1957. 307 pp. Illus. $9.50.

There has long been needed a rather comprehensive textbook and appraisal of engineering models and scale-up methods. This book, written especially for chemical engineers, summarizes well both the state of knowledge and the applications of dimensional analysis for predicting performance of large-scale operations from laboratory and pilot-plant data. All the important topics of chemical engineering—including reactor kinetics, combustion, and corrosion—are encompassed. Each chapter can be read independently of the others, with little more background than is contained in the first three introductory chapters.

Chapter 5, on differential equations, is exceptionally good and the methods outlined therein on the development of various dimensionless groups give a clearer insight to dimensional analysis than do the usual methods of unit homogeneity of Rayleigh and Buckingham.

In spite of the many dimensionless groups discussed in this book (and in others), I cannot help feeling that there are only three or four such groups which are basic and have physical significance. All others are derivable from these basic groups or are quite synthetic. Moreover, all suffer from rather serious defects. Dimensionless graphs are either extremely sensitive or relatively insensitive. They compound the errors of whatever measurements are involved in the variables employed. Actually, as used by most engineers, dimensionless groups are desensitizing, and many functional relationships derived by their empirical use in engineering data are deceptive. Although the authors have failed to stress these limitations, they have nevertheless taken great pains, in their discussions and examples of applications, to point out the significance of various dimensionless groups. This has been needed, and for this reason and because the book is well written, I am convinced that it should be added to the library of every practicing chemical engineer.

J. M. DALLAVALLE
Georgia Institute of Technology

New Books

New Research Techniques of Neuroanatomy. A symposium sponsored by the National Multiple Sclerosis Society. William F. Windle, Ed. Thomas, Springfield, Ill., 1957. 107 pp. $4.75.

Scientific and Technical Translating. And other aspects of the language problem. United Nations Educational, Scientific and Cultural Organization, Paris, 1957. 282 pp. $4.20.

Soil, the Yearbook of Agriculture, 1957. U.S. Department of Agriculture, Washington, 1957 (order from Supt. of Documents, GPO, Washington 25). 797 pp. $2.25.

Vertebrates of the United States. W. Frank Blair, Albert P. Blair, Pierce Brodkorb, Fred R. Cagle, George A. Moore. McGraw-Hill, New York, 1957. 828 pp. $12.

Meetings and Societies

Pure and Applied Chemistry

The international organization of the science of chemistry is effected through a union meeting of national delegates, who pass on such actions as nomenclature, publications, and organizational matters. These actions were taken in meetings of the International Union of Pure and Applied Chemistry, held in Paris 16 July, two days before the 16th congress of the union convened, and 25 July, the day following the close of the congress. To effect the many discussions and actions, the union has established working divisions of Organic, Inorganic, Analytical, Industrial, and Biological Chemistry, and each of these divisions has a number of commissions, of which more than 40 held one or more sessions during the week of the congress 18–24 July. More than 4000 chemists from 45 countries took part in the congress, at which 912 technical papers were presented, of which about half were in the field of organic chemistry and the balance in inorganic and physical chemistry.

A series of 17 main lectures was arranged for the beginning and conclusion of the principal sessions. The invited speakers included a broad cross section of chemical scientists from many countries, of whom three, Glenn T. Seaborg, Paul D. Bartlett, and Leo Brewer, were from the United States. The speaker at the opening session was Giulio Natta of Italy, and at the closing session the technical speaker was Alexander Terenine of Russia.

The meeting in Paris of the international union had been arranged in order to recognize the 100th anniversary of the founding of the Société Chimique de France. Preceding the congress, a special formal session was held, 16 July, in the grand amphitheater of the Sorbonne, at which representatives, in colorful academic and formal attire, of the many chemical and scientific societies and academies, as well as of many universities, presented formal scrolls. President Delaby of the French Chemical Society spoke on the advances of chemistry in France.

This session was attended by the President of the Republic of France and by diplomatic representatives as well as by many of the world's leading chemists. The symphony orchestra of the Garde Republicaine provided music for the occasion, including the appropriate *Sorcerer's Apprentice,* following the address by Delaby.

On 22 July, a formal banquet was held at the Chateau de Versailles, at which more than 1000 chemists were present.

In addition to the papers at the scheduled congress, some special symposia were arranged, before and after the main congress, such as one on "Proteins," which was sponsored by the Section for Biological Chemistry and which met in Paris 25–29 July.

WALLACE R. BRODE
National Bureau of Standards, Washington, D.C.

Molecular Spectroscopy

The Third Biennial European Molecular Spectroscopic Conference was held in Freiburg, Germany, 8–14 July. The meeting was arranged by R. Mecke, the director of the Institut für Physikalisches–Chemie of the University of Freiburg. Ample opportunity was provided for discussion, and, while simultaneous sessions were arranged for both morning and afternoon, evenings were left for group discussions.

More than 400 molecular spectroscopists attended the meeting, at which 116 papers were presented covering the fields of infrared spectroscopy, microwave spectroscopy, ultraviolet spectroscopy, nuclear magnetic resonance spectral theory, and Raman spectra. In addition to the technical research papers, four general review discussions were presented. These were by E. B. Wilson on "Recent developments in microwave spectroscopy"; H. W. Thompson on "Infrared intensity measurements"; R. E. Richards on "Nuclear magnetic resonance spectroscopy"; and B. Vodar on "Molecular spectra studies in the extreme ultraviolet."

The conference was truly international, with representatives from 23 nations and about an equal distribution among English, French, and German in the language of presentation. The American presentation at the meeting was about 10 percent of the scheduled program, and about 30 Americans were in attendance. In addition to the active participation by a large number of East German scientists, there were a few scientists from the U.S.S.R., Hungary, Rumania, and Czechoslovakia.

Society Elections

■ Society of Protozoologists: pres., Gordon H. Ball, University of California, Los Angeles; vice pres., William Balamuth, University of California, Berkeley; treas., Daniel M. Lilly, St. John's University, Brooklyn, N.Y. Representative to the AAAS Council is Harold E. Finley, Howard University, Washington, D.C.

■ National Science Teachers Association: pres., Glenn O. Blough, University of Maryland; pres.-elect, Herbert A. Smith, University of Kansas; sec., H. M. Louderback, Lewis and Clark High School, Spokane, Wash.; treas., Robert T. Lagemann, Vanderbilt University.

■ Society of General Physiologists: pres., Folke Skoog, University of Wisconsin; vice pres., C. L. Prosser, University of Illinois; sec., Frederick Sherman, Brown University; treas., A. M. Chase, Princeton University; Representatives to the AAAS Council, F. H. Johnson, Princeton University, and K. S. Cole, National Institutes of Health.

■ American Society for Horticultural Science: pres., W. T. Pentzer; vice pres., Freeman S. Howlett; sec.-treas., Roy E. Marshall.

■ American Society of Zoologists: pres. elect, V. C. Twitty, Stanford University; sec., Gairdner Mement, Goucher College; treas., Jane Oppenheimer, Bryn Mawr College.

■ Society of Exploration Geophysicists: pres., O. C. Clifford, Jr., Atlantic Refining Company, Dallas, Tex.; v. pres., Ben F. Rummerfield, Century Geophysical Corporation, Tulsa, Okla.; sec.-treas., Howard E. Itten, Empire Geophysical, Inc., Forth Worth, Tex.

Forthcoming Events

November

2–4. American Soc. for the Study of Arteriosclerosis, 11th annual, Chicago, Ill. (L. N. Katz, Michael Reese Hospital, Chicago 16.)

2–8. World Metallurgical Cong., 2nd, Chicago, Ill. (W. H. Eisenman, American Soc. for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.)

2–10. Measuring Instruments and Automation, internatl. cong., Düsseldorf, Ger-

many. (Nordwest Deutsche Ausstellungs Gesellschaft, M.B.H., Ehrenhof 4, Düsseldorf.)

3. American College of Dentists, annual, Miami, Fla. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis 8, Mo.)

3. Society of Vertebrate Paleontology, annual, Philadelphia, Pa. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

3–9. Pan American Cong. of Pharmacy and Biochemistry, 4th, Washington, D.C. (G. Griffenhagen, Smithsonian Institution, Washington 25.)

4–5. Crystal Structure Analysis by IBM 704 Computer, NBS Conf., Washington, D.C. (V. Vand, Pennsylvania State Univ., University Park.)

4–5. Society of Vertebrate Paleontology, technical sessions, Atlantic City, N.J. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

4–6. Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn. (D. D. Cowen, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tenn.)

4–6. Geological Soc. of America, annual, Atlantic City, N.J. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

4–6. Mineralogical Soc. of America, annual, Atlantic City, N.J. (C. S. Hurlbut, Jr., Dept. of Mineralogy, Harvard Univ., Cambridge 38, Mass.)

4–6. Paleontological Soc., annual, Atlantic City, N.J. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge 38, Mass.)

4–6. Society of Economic Geologists, annual, Atlantic City, N.J. (H. M. Bannerman, U.S. Geological Survey, Washington 25.)

4–7. American Dental Assoc., annual, Miami, Fla. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

6–8. Electronic Techniques in Medicine and Biology, Boston, Mass. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

7–8. Society for Applied Spectroscopy, 12th annual, New York, N.Y. (J. Hansen, 27 Tulsa Ave., Metuchen, N.J.)

7–8. Television and Radio in the Health Field, conf., Chicago, Ill. (American Medical Assoc., 535 N. Dearborn St., Chicago 10.)

7–9. Animal Care Panel, 8th annual, San Francisco, Calif. (R. J. Flynn, ACP, Box 299, Lemont, Ill.)

7–9. Society of Rheology, annual, Princeton, N.J. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York.)

10–13. Society of American Foresters, 57th annual, Syracuse, N.Y. (H. Clepper, SAF, 415 Mills Bldg., Washington 6.)

10–13. Xi Sigma Pi, Syracuse, N. Y. (J. R. Parker, School of Forestry, Univ. of Georgia, Athens.)

10–14. Society of Exploration Geophysicists, 27th annual, Dallas, Tex. (J. C. Hollister, Colorado School of Mines, Golden.)

11–13. Radio Fall Meeting, IRE, Toronto, Ont., Canada. (V. Graham, RETMA, 11 W. 42 St., New York 26.)

11–14. American Petroleum Inst., 37th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

11–15. American Public Health Assoc., 85th annual, Cleveland, Ohio. (R. M. Atwater, APHA, 1790 Broadway, New York 19.)

11–15. American Soc. of Professional Biologists, annual, with American Public Health Assoc., Cleveland, Ohio. (A. F. Borg, Dept. of Bacteriology, Kansas State College, Manhattan.)

13–15. American Meteorological Soc., College Station, Tex. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

13–15. Clinical Chemistry Symp., Cleveland, Ohio. (F. E. Bunts Educational Inst., Cleveland, Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

13–15. Standards, 8th national conf., San Francisco, Calif. (American Standards Assoc., 70 E. 45 St., New York 17.)

13–16. Society of Naval Architects and Marine Engineers, 65th annual, New York. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

14–15. Operations Research Soc. of America, Pittsburgh, Pa. (M. L. Ernst, Box 2176, Potomac Station, Alexandria, Va.)

14–16. American Inst. of Mining, Metallurgical, and Petroleum Engineers, semiannual, Chicago, Ill. (H. N. Appleton, AIME, 29 W. 39 St., New York 18.)

14–16. American Soc. of Refrigerating Engineers, Chicago, Ill. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

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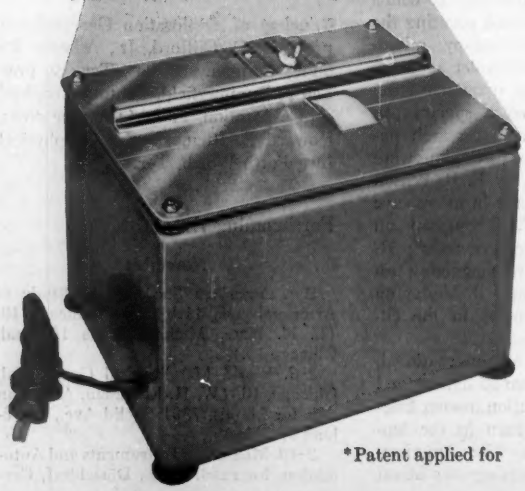

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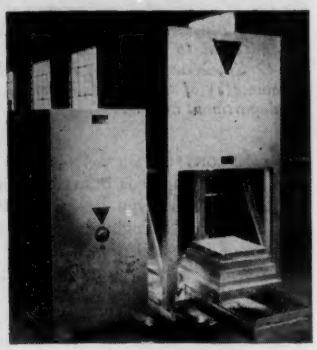

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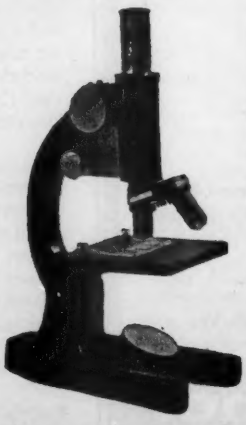

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14–16. Inter-Society Cytology Council, annual scientific, Augusta, Ga. (P. F. Fletcher, 634 N. Grand Ave., St. Louis 3, Mo.)

17–22. Radiological Soc. of North America, annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse, N.Y.)

18–21. Magnetism and Magnetic Materials Conf., Washington, D.C. (L. R. Maxwell, U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md.)

18–22. American Soc. of Agronomy, annual, Atlanta, Ga. (L. G. Monthey, ASA, 2702 Monroe St., Madison, Wis.)

18–22. Citrus Virus Diseases Conf., Riverside, Calif. (J. M. Wallace, Dept. of Plant Pathology, Univ. of California, Riverside.)

18–9. Pacific Science Cong., 9th, Bangkok, Thailand. (Pacific Science Board, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

20–24. National Assoc. for Mental Health, annual, Atlantic City, N.J. (NAMH, 10 Columbus Circle, New York 19.)

22. Ultraviolet Scanning Microscopy Symp., Philadelphia, Pa. (H. K. Schlegelmilch, RCA Victor TV Div., Bldg. 204–2, Section 219, Cherry Hill, Camden 8, N.J.)

25–27. American Acad. for Cerebral Palsy, 11th annual, New Orleans, La. (R. R. Rembolt, Iowa Hospital–School State University of Iowa, Iowa City.)

25–27. Physics and Dynamics of Fluids, APS, Bethlehem, Pa. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

26–28. Central Assoc. of Science and Mathematics Teachers, 57th annual, Chicago, Ill. (L. Panush, Henry Ford High School, Detroit 19, Michigan.)

28–29. American Physical Soc., St. Louis, Mo. (K. K. Darrow, Columbia Univ., New York 27.)

29–30. American Soc. of Animal Production, annual, Chicago, Ill. (H. H. Stonaker, Animal Husbandry Dept., Colorado State Univ., Fort Collins.)

December

1–6. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

1–15. Bahamas Medical Conf., 4th, Nassau, Bahamas. (B. L. Frank, 1290 Pine Ave., West, Montreal, Que., Canada.)

2–5. Entomological Soc. of America, annual, Memphis, Tenn. (R. H. Nelson, ESA, 1530 P St., NW, Washington 5.)

4–8. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

4–10. American Acad. of Optometry, annual, Chicago, Ill. (C. C. Koch, 1506–1508 Foshay Tower, Minneapolis 2, Minn.)

5–7. Texas Acad. of Science, annual, Dallas. (G. C. Parker, Education Dept., Texas A&M College, College Station.)

(See issue of 20 September for comprehensive list)

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■ REMOTE-CONTROL MICROSCOPE for nuclear metallography is based on designs of the Atomic Energy Research Establishment, Harwell, England. The inverted microscope is provided with tubular optical devices, called "transport optics," one for illumination and another for visual microscopy or photomicrography at a distance of 30 in. Several light sources are available. These are mounted outside the shielding. An objective changer, for six objectives and a micro hardness tester, is remotely controlled. The optical bench on the viewing side will accommodate a reflex camera, a cine camera, or a television camera. (Shandon Scientific Co., Ltd., Dept. S614)

■ DENSITY-MEASURING INSTRUMENT consists of a Pyrex pipe, a Pyrex plummet contained within the pipe, and a calibrating chain weight of platinum or tantalum. Liquid to be measured is passed continuously through the pipe. Temperature and zero-set adjustments are provided. A model for use at temperatures to 220°C is available with ranges as small as 0.01 and as large as 0.5 specific gravity; it can be used at pressures up to 125 lb/in². (Precision Thermometer and Instrument Co., Dept. S615)

■ CRYSTAL FILTERS provide sharp-rejection band pass at high frequencies. The filters use several wafers of quartz, usually two, four, or eight, arranged in a bridge network configuration. The filters are said to be useful at frequencies beyond the range of *LC* or mechanical filters. (Hycon Manufacturing Company, Dept. S618)

■ ELECTRODELESS CONDUCTIVITY METER, for use with liquids that would clog conventional cells, utilizes input and output toroid coils that are coupled by the liquid flowing through them. The input coil is excited by audio-frequency current. The voltage developed in the output coil is read as a measure of the conductivity of the liquid. (Industrial Instruments Inc., Dept. S619)

■ VAPOR CHROMATOGRAPH is designed to take three rough cuts of a total sample, without preseparation, and make three simultaneous analyses of the cuts. Three stages operate in series, unresolved components being fed into the following

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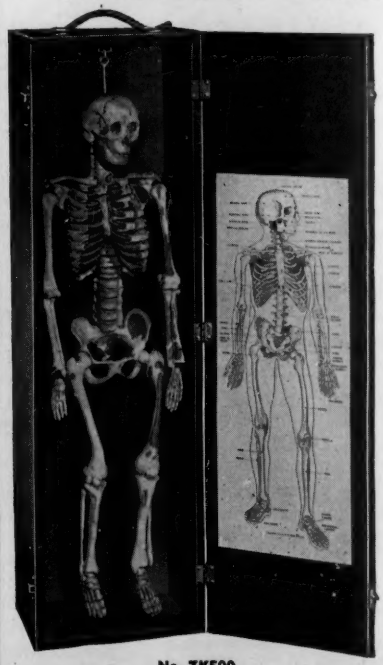

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■ CONVERTER for deriving a direct-current signal proportional to input frequency in the range 250 to 2500 cy/sec is capable of two-thirds of full-scale response in 1 msec. Output voltage into 30 ohm is 0.6 v. Frequency range can be expanded to 25 to 10,000 cy/sec. (Potter Aeronautical Corp., Dept. S622)

■ CATHODE-RAY OSCILLOGRAPH is transistorized and battery operated. Although only an experimental instrument has been made, the feasibility of commercial models has been demonstrated. The entire instrument consumes less than 5 w. Frequency response from 20 cy/sec to 150 kcy/sec is within 3 db down. Sensitivity is 200 mv/in. through a high-impedance input and 500 mv/in. through a low-impedance input. Rise time is less than 2 μsec, and writing rate is variable from 3 to 100,000 μsec/in. (Allen B. DuMont Laboratories, Inc., Dept. S629)

■ PULSE GENERATOR furnishes two pulses, both at repetition rates from 10 cy/sec to 1 Mcy/sec. Each of the pulse trains may be independently delayed from 0 to 10,000 μsec with respect to a common synchronizing pulse. Width of the pulses may also be varied independently from 0.08 to 10,000 μsec. The pulses are available separately or mixed at the output. (Rutherford Electronics Co., Dept. S624)

■ TEAR TESTER may be mounted on a microscope to permit observation of tearing and drawing properties of paper, yarn, and other materials. The jaws that hold the specimen are driven on ways by a reversible synchronous motor. Rate of separation of jaws may be selected by means of change gears. Maximum tension is 50 lb. Maximum separation is 8 in. (Custom Scientific Instruments, Inc., Dept. S626)

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■ PULSE DELAY UNIT allows delays of 5, 10, 15, 20, 50 and 100 mμsec and combinations of these. Rise-time for a step-function input is less than 1 mμsec for delay of 25 mμsec or less, and less than 5 mμsec for a 100-mμsec delay. (Electrical and Physical Instrument Corp., Dept. S632)

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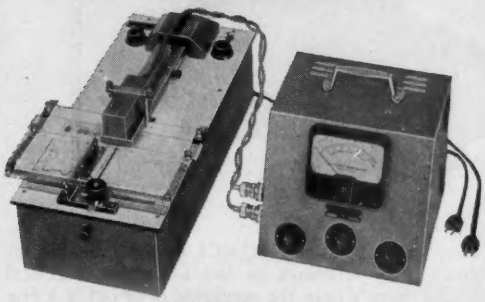

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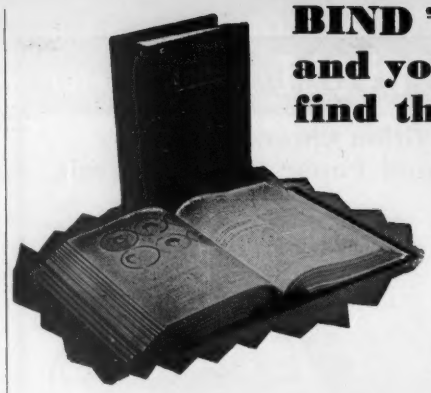

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New! Combines the miracle of Silicones with a non-woven, all rayon cloth. Used over and over (washable) to dust, polish, protect, anti-fog: mirrors, reflectors, lenses, coated optics, crystal glass, lucite, other plastics. Won't scratch. Lintless, non-oily. Cloth size 18 x 16".

Stock No. 60,059-W Package of 3 cloths ... $1.00 Pstpd.
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Lower Prices on Larger Quantities

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See in the dark—without being observed. War surplus Sniperscope M-2, Gov't. cost about $1200. Instrument complete, ready to use. Includes Power Pack, infrared light source. Will operate from 6 V auto battery. Battery or transformer available.

Stock No. 85,053-W $150.00 f.o.b.

Save still more money! Build your own Sniperscope! We will furnish instructions—parts, including: Power Packs, 1P25A image tubes, light units, filters, etc. For details—request FREE Bulletin A-26-W.

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Great Project for Geophysical Year!

A fascinating new field. You can build your own Solar Furnace for experimentation—many practical uses. It's easy—inexpensive, use your scrap wood. We furnish instruction sheet. This sun powered furnace will generate terrific heat—2000° to 3000°. Fuses Enamel to metal. Produces many unusual fusing effects. Sets paper aflame in seconds. Use our Fresnel Lens—14¾" diameter . . . f.l. 14".

Stock No. 70,130-W package of 1 .... $6.00 Postpaid
Stock No. 70,131-W package of 2 .... 11.00 Postpaid
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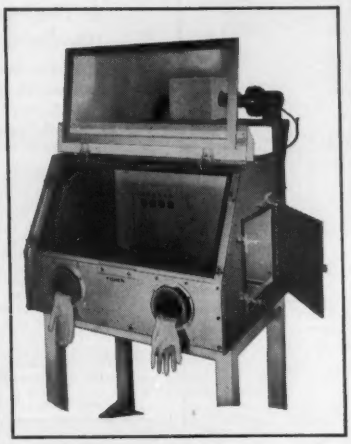

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available from stock

Here's the latest development in isolation units: a compact, *moderately-priced* self-contained lab-within-a-lab. It has its own services, air supply and exhaust system (with the highest-efficiency filter commercially available today). The *same* unit can be used as a closed system or open system . . . with positive or negative pressures.

Three models of the Isolator/Lab are available: the BACTERIOLOGY-VIROLOGY unit; the RADIOCHEMISTRY unit; and the CONTROLLED-ATMOSPHERES unit, an unusually versatile pressurized assembly guaranteeing complete isolation of a product or sample from surrounding environment.

All are available *from stock*—plus a wide variety of accessories to meet your special needs.

Details? **Send for 8-page BULLETIN: 139 Fisher Building Pittsburgh 19, Pa.**

B-55a

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ADDRESS.....
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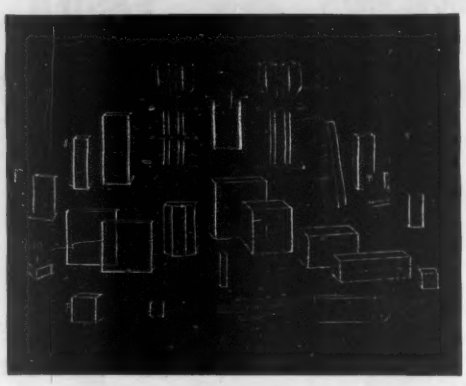
GLASS ABSORPTION CELLS made by KLETT



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Klett Manufacturing Co.

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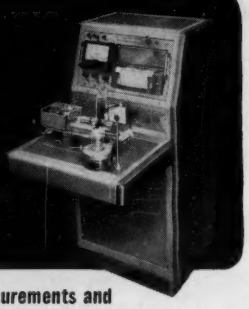

for simultaneous measurements and recording of variable and constant pH factors

Allows automatic techniques to be applied to unknown compounds, to rapidly and accurately determine:

A. Ionization constants, from which are determined minimum equivalent weights, purity, and structural features.

B. Kinetic analysis of reactions.

FEATURES:

• Speeds analysis • Provides permanent record • Automatic cut-off when reagent is exhausted permits unattended operation for round-the-clock measurements of slow reactions. A port in the cell permits addition of reagents during operation • Choice of micrometer, microburet or micrometer syringe, quick substitution for rapid titrant changes • Accuracy of 0.02 pH units • Complete titration curves can be obtained within two minutes • Typical 10 cubic centimeters sample volume capacity (other capacities available to suit specific needs) • Cell temperature can be regulated by controlled water bath (optional) • Magnetic stirrer provided • Range switch, which varies the ratio of titrator travel to recorder pen movement, ensuring complete on-paper plot without changing reagent concentration after a reaction has started

Scientific Instruments Division

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PERSONNEL PLACEMENT

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

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Single insertion	$22.00 per inch
13 times in 1 year	21.00 per inch
26 times in 1 year	20.00 per inch
52 times in 1 year	19.00 per inch

For **PROOFS on display ads,** copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:

Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

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CHALLENGING FUTURE FOR MICROBIOLOGIST

The Research Council of Alberta, in its petroleum and coal research, desires an able scientist to initiate microbiological research. Investigations are to bear on the influence of microbiological factors in the origin and alterations of oil and coal. This position provides an opportunity for fine basic research in relation to two of the Council's major projects. Send your résumé to Secretary, Research Council of Alberta, 87 Avenue and 114 Street, Edmonton, Alberta, Canada. 9/27; 10/4

Experimental Histopathologist. Ph.D. or M.D. Cancer and cardiovascular research program. Give qualifications and salary expected. W. D. Salmon, Alabama Polytechnic Institute, Auburn, Alabama. 10/4

POSITIONS OPEN

Director, diagnostic and research tuberculosis laboratory, central Florida, physician or non-physician microbiologist or clinical chemist. Part-time employment will be considered. Write Dr. Albert V. Hardy, Director, Bureau of Laboratories, State Board of Health, P.O. Box 210, Jacksonville, Florida. uc

MICROBIOLOGIST. Ph.D., recent graduate with experience or training in tissue culture and virology. Responsible research position with rapidly expanding veterinary biological and pharmaceutical manufacturer located in Midwest. Fine working conditions, liberal employee benefits, including a profit-sharing program, and excellent opportunity for advancement. Please send complete résumé, including approximate salary requirements, references, and data available in first letter. Our employees know of this ad and all inquiries will be held in strict confidence. Box 267, SCIENCE. 10/4, 11, 18

Microbiologist—Tissue Culture. Position available for very able Ph.D. in eastern pharmaceutical company. Would prefer experience in tissue culture, but willingness to learn is an acceptable substitute. Please indicate qualifications. Box 259, SCIENCE. 9/27; 10/4

(a) Physician well qualified in pharmacology; important post, major pharmaceutical company; West. **(b) Physiologist or Biophysicist,** Ph.D., well trained in general physiology or neurophysiology with adequate research experience; should be interested in general area of effects of light and radiant energy on human organism; newly created position as result of expansion program on light; university city, Midwest. **(c) Assistant Director,** excellently equipped laboratories for scientific criminal investigation; Ph.D., trained in physiology, pharmacology, human anatomy, pathology. **(d) Clinical Chemist,** Ph.D., qualified to supervise department; ample opportunity for research; department well staffed, well equipped; 250-bed general hospital; New England; $9500, minimum. **(e) Bacteriologist** trained in biochemistry; research in hypersensitivity, teaching, state university, West. S9-4 Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

POSITIONS OPEN

VENEZUELAN INSTITUTE FOR NEUROLOGY AND BRAIN RESEARCH CARACAS, VENEZUELA

invites applications for the position of Scientific Director of Reactor Operations

Candidates should have a degree in one of the physical sciences or engineering and experience in the operation of nuclear reactors and in the direction of research activities relating to the use of reactors and associated equipment.

For further details regarding terms of employment, salary, living conditions, etc., candidates should submit detailed applications to

W. H. Zinn
General Nuclear Engineering Corporation
P.O. Box 245, Dunedin, Florida

NEW WORLD-WIDE GRADUATE AWARD DIRECTORY. First compilation ever prepared for American scientists, teachers and librarians to subsidize their education and research in over 350 universities in 45 states, 30 foreign lands. Stipends $200–$10,000. Complete information. Pre-publication price before 15 Nov. 1957, $1.50. Regular price, $2. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. 10/4, 11, 18, 26; 11/1

PERSONNEL PLACEMENT

POSITIONS OPEN

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

POSITIONS WANTED

Bacteriologist, Ph.D.; experienced also in various metabolic studies. Academic-research or industrial-research. Box 266, SCIENCE. 10/4, 11

Biochemist, Ph.D.; 3 years, full-time university teaching; 6 years, director, research, well-known institution; recognized as authority in field of steroid analysis. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

POSITIONS WANTED

Microbiologist, Ph.D., varied experience, food, physiology. Desires teaching in field with opportunity for research. Box 270, SCIENCE. X

Zoologist, 29, Ph.D.; major, parasitology. Research and teaching experience. Desires teaching or research position. Box 269, SCIENCE. X

The MARKET PLACE

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WANTED TO PURCHASE . . . **SCIENTIFIC PERIODICALS and BOOKS**

Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.

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Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, Inc. Boston 19, Massachusetts

Best Book Contest for 1957

$1600 Cash Awards. All Types of manuscripts invited. For contest rules and details of famous publishing plan, write for Brochure 88.

Pageant Press, 101 Fifth Ave., N.Y. 3

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AAAS Publication No. 22

By members of the staff of the National Cancer Institute, National Institutes of Health, U.S. Public Health Service

Edited by FOREST RAY MOULTON

7½" x 11½", double column, cloth, references, 20 tables, 52 illus. Published 1945—Now offered at reduced price

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TOXICITY TESTS following FDA procedures, for chemicals, foods, drugs, cosmetics, pesticides, additives. Biological assays. Screening tests. Complete research and development services. No obligation for estimates. Call or write Arthur D. Herrick, Director.

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Est. 1921 Walnut St., Philadelphia 3, Pa.
SINCE 1870
Food & Drug PROBLEMS
Pharmacological BACTERIOLOGICAL CHEMICAL

WOULD YOU LIKE A ROYALTY INCOME?

Have you a potential drug product requiring further clinical development? If you have please write telling only what it is for, how it is used and what has been done with it so far. If we are interested will work out further details with you. **BOX 249, SCIENCE**

FOOD RESEARCH LABORATORIES INC.
OUR 35th YEAR
RESEARCH
ANALYSES CONSULTATION
BIOLOGICAL, NUTRITIONAL AND TOXICOLOGICAL STUDIES FOR THE FOOD, DRUG AND ALLIED INDUSTRIES
48-14 33rd STREET, LONG ISLAND CITY 1, N.Y.
Western Office—9231 VENICE BOULEVARD, CULVER CITY, CALIF.

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albino rats *
**Descendants of the Sprague-Dawley and Wistar Strains*
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Hypophysectomized Rats
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HENRY L. FOSTER, D.V.M.
President and Director
THE CHARLES RIVER BREEDING LABS.
Dept. B, Wilmington, Mass.

THE JUNIOR
Garceau
Electroencephalograph
Price $575.00 complete.
No Batteries
Requires no Shielding
Prompt Delivery
A.C. Operated
Inkless Writing
Shipped Ready to Run
ELECTRO-MEDICAL LABORATORY, INC.
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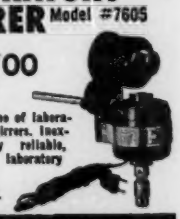
• **HYPOPHYSECTOMIZED RATS**
Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc.
8159 South Spaulding Ave., Chicago 29, Ill.

Palo **LABORATORY STIRRER** Model #7605
$27.00



One of complete line of laboratory-tested PALO Stirrers. Inexpensive, thoroughly reliable, suitable for most laboratory stirring operations.
Write for Bulletin X-1.
PALO LABORATORY SUPPLIES, Inc.
81 Reade St., New York 7

STEROIDS C^{14}
and other tagged compounds
OF HIGH RADIOPURITY
ISOTOPES SPECIALTIES COMPANY INC.
P.O. Box 688 Burbank, Calif.

APPLICATION FOR HOTEL RESERVATIONS

124th AAAS MEETING

Indianapolis, December 26-30, 1957

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Indianapolis. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Indianapolis and thereby avoid delay and confusion. (Exception: Members of the American Astronomical Society who wish reservations at the Marott Hotel, 2625 North Meridian Street, are asked to correspond directly with that hotel.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague. Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 to 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Rates for Rooms with Bath

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 19, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Antlers	$4.50–10.00	$7.00–12.00	$10.50–12.00	$14.50–19.50
Claypool	7.00–10.00	9.50–14.00	10.50–14.00	13.50–34.00
Continental	8.00–10.00	8.00–12.00	8.00–12.00	12.00–15.00
Marott	7.00–14.50	9.00–14.50	10.00–17.50	14.50 and up
Severin	6.00– 9.00	8.50–12.50	11.00–15.00	25.00
Sheraton-Lincoln	6.50–11.50	9.85–15.00	13.35–16.00	24.35 and up
Warren	6.50–10.50	8.50–12.50	12.00–13.00	25.00–35.00
Washington	5.50–10.00	7.00–11.00	11.50–16.00	18.00–45.00

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
1201 Roosevelt Building
Indianapolis 4, Ind.

Date of Application .....

Please reserve the following accommodations for the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

First Choice Hotel ..... Second Choice Hotel ..... Third Choice Hotel .....

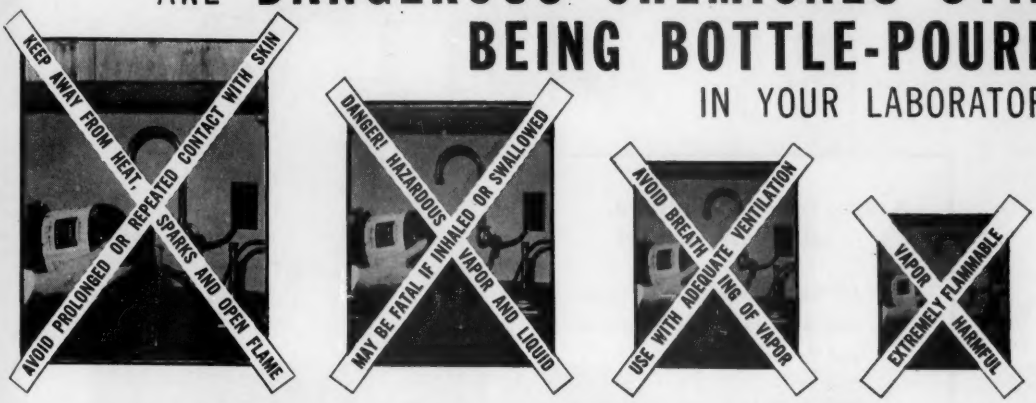
DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

ARE DANGEROUS CHEMICALS STILL BEING BOTTLE-POURED IN YOUR LABORATORY?


KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME
AVOID PROLONGED OR REPEATED CONTACT WITH SKIN
DANGER! HAZARDOUS VAPOR AND LIQUID
MAY BE FATAL IF INHALED OR SWALLOWED
AVOID BREATHING OF VAPOR
USE WITH ADEQUATE VENTILATION
VAPOR HARMFUL
EXTREMELY FLAMMABLE

ELIMINATE THIS HAZARDOUS OPERATION WITH

the CORINTH *Finger-Tip* FLUID DISPENSER*

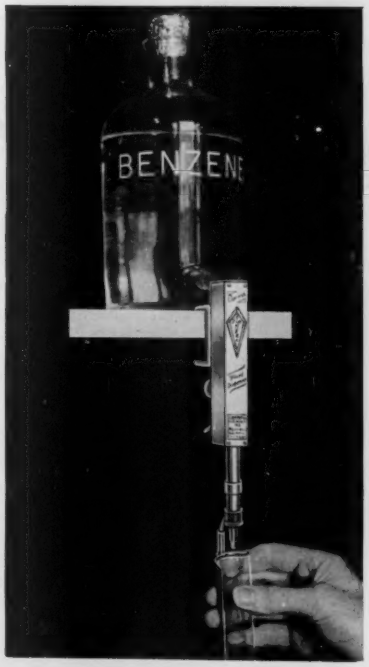
NOW BEING USED IN LEADING LABORATORIES†

No bottle drip . . . no finger burns . . . no table-top corrosion!
No back-and-forth pouring . . . no vapor escape . . . no waste!

★ Quick, easy to use . . . operates at touch of fingertip or container!

★ Sterile . . . sanitary . . . absolutely no contact of liquids with metal!

★ Accurate . . . positive delivery control to the drop!



Semi-automatic fluid dispenser eliminates losses, contamination, unwieldiness and guesswork of old-fashioned bottle-pouring. Ideal for frequent dispensing of small amounts of fluids for routine laboratory, pharmaceutical and hospital needs . . . reagents, medicinals, pharmaceuticals, sterile solutions, corrosives, volatile solvents, etc. Can be drop-calibrated for quantitative delivery of milliliter amounts . . . will deliver one pint or more per minute in fully opened position.

Liquids pass through a continuous length of suitable chemically resistant delivery tubing. Constructed of stainless steel and anodized nickel-acetate sealed aluminum components, for high corrosion resistance and lifelong trouble-free performance . . . attractively finished by the alumilite process. Safety lock-knob prevents accidental opening when not in routine use . . . nozzle vial-shield prevents vapor loss or microbial contamination . . . affixes to any shelf or flat surface. Recommended for use with bottom-tubulated aspirator bottles utilizing gravity feed, or with siphon feed from standard containers and storage carboys.

L-950 CORINTH *Finger-Tip* FLUID DISPENSER complete with Pyrex Brand glass nozzle, shield and Tygon R-3603 delivery tubing **$17.50**

ASPIRATOR BOTTLES and DELIVERY TUBING for every purpose available.

PALO LABORATORY SUPPLIES, Inc.
81 Reade Street • New York 7, N. Y.

*Patent pending

A *new, corrosion-resistant, all-purpose cabinet* . . .

Of white Formica both inside and outside—corrosion-resistant throughout

With built-in levelling devices

Swivel casters and handles to facilitate rolling under a bench, etc.

3673.

Thomas CHROMATOGRAPHY CABINET

With vapor-tight, hinged cover, for preparing two-dimensional paper chromatograms by descending or ascending techniques. The cabinet frame and cover are 1-inch plywood bonded to white Formica inside and outside to provide adequate insulation under normal conditions. Formica is practically unaffected by solvents generally used, and its resistance to corrosive properties of mineral acids and their salts is superior to Stainless steel at room temperatures.

Inside dimensions are 25¾ inches long × 19½ inches wide × 27½ inches deep, with double-paned glass window in one end, 17¼ inches high × 11½ inches wide. Black phenolic plastic fittings are built in for 4 solvent assemblies which take 8 sheets of suitable paper up to 18¼ × 22½ inches. Swivel casters and two handles permit ready positioning, but in use four adjustable leveling feet carry the weight and fix location. Satisfactory working position, with level solvent troughs, is attained by adjusting feet in conjunction with two liquid levels mounted on cabinet.

The cover, sealed by means of a Neoprene gasket, is attached by means of a nickel-plated brass piano hinge with limit chains at both ends to facilitate handling, and has two trunk latches which insure tight closure. Four openings, ½-inch diameter, in the cover, fitted with Neoprene stoppers, size No. 00, facilitate replenishment of solvent during a run; a drain pipe in bottom permits flushing as required.

3673. Chromatography Cabinet, Formica, Thomas, as above described, complete with assortment of accessories, but without paper or siphon for drainage **300.00**

3673-B. Ditto, but without accessories other than a plastic rod to prevent tipping of troughs **238.75**

Detailed descriptive bulletin sent upon request.

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